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(Agricultural Series, No. 1.)

1679

THE AGRICULTURAL LEDGER.

1892—No. 1.

INDIAN FODDER GRASSES.

[*Dictionary, Economic Products, Vol. III.*, F. 672.]

SOUTH INDIAN FODDERS.

A Note by MR. BENSON *on the Experiments conducted by* DR. VAN GEYZEL.

The results of a series of analyses of chief kinds of straw on which the cattle of this Presidency are generally fed are given below. They were made by J. L. Van-Geyzel, Esq., M.B., C.M., F.C.S., F.I.C., Chemical Examiner, Madras, and to them the following explanatory remarks are appended.

NITROGEN.

In nearly all these analyses the proportion of nitrogen existing in the fodders as albuminoids has been separately determined. A large percentage of the nitrogen in fodders is now known to occur as amides, the feeding value of which has not yet been ascertained, though it seems probable that when used along with albumen, they are capable of partially replacing the flesh-forming compound. So little is as yet known, however, as to the true value of these amides that they are usually left out of account, and in the analyses of straw, which are generally published, the whole of the nitrogen in fodder is assumed to be present as albumen—the *total nitrogen* obtained in the analysis being converted into its equivalent of albuminoids. In consequence of this the figures given in the latter part of the comparative table below, in which the average composition of South Indian fodders is shown together with that of various English and American fodders, are incomplete in the case of the latter under the column "Nitrogen in non-albuminoid compounds."

Amides.

ALBUMINOID RATIO.

The "albuminoid ratio" or "nutritive relation" is the relation of the albuminoids to the total carbo-hydrates, including with the latter the "fibre" and the "starch equivalent of fat" (1 of fat being reckoned as = 2·44 of starch), and it is an important element in the valuation of a food, though the real value of a fodder, of course, depends mainly on the amount of "assimilable nutriment" contained in it. The term "Fibre" in the analyses includes the material of the straw which is neither albuminoid nor oily nor starchy, etc., and which resists the solvent action of boiling acid and alkaline solution; in it is locked up a portion of the albuminoids, fat and mineral matter, which is inaccessible as food in the case of human beings on account of its indigestibility, but which is more or less accessible to ruminants, who are said to be able to digest about half the amount of this fibre. Before the absolute value of any of these fodders can be ascertained, it will be necessary to determine the "coefficient of assimilation" for each constituent in each kind of fodder.

Assimilation.

This can only be done by a series of experiments upon animals fed on selected fodders; the weight of fodder used being known, the weight of the constituents administered as food is readily calculated from the analytical results: the solid excrements of the animals are then weighed and analysed, the difference (after making certain deductions) representing the amount of each constituent, assimilated.

It is therefore obvious that a chemical analysis, while it reveals the composition and total amount of nutriment contained in a fodder, does not alone afford sufficient data for an opinion as to its absolute feeding value; and in the absence of information as to the true proportion of digestible nutriment contained in these fodders, a complete comparison between them and the fodders of other countries is impossible. The results of the analyses are nevertheless comparable in a general way and afford an indication of the relative nutritive values of the fodders which have been examined.

COMPARATIVE ANALYSES.

These remarks should be borne in mind in looking at the following table of the average results of the analyses compared with average figures as to composition of English and American fodder straw:—

Description of fodder.	Moisture.	Ash.	Fibre.	Fat.	Carbo-hydrates.	Albuminoids.	Nitrogen in non-albuminoid compounds.	Albuminoid ratio.
AVERAGES OF SOUTH INDIAN.								
Conf. with O. 271. 1. Paddy (**Oryza sativa**) straw.	8·12	16·87	30·02	2·19	40·65	1·78	·36	1:43
S. 2440. 2. *Cholum* (**Sorghum vulgare**) straw.	8·06	7·08	30·93	3·14	48·91	1·61	·26	1:54
E. 182- 3. *Ragi* (**Eleusine Coracana**) straw.	9·88	12·10	28·22	2·37	44·88	2·19	·35	1:36
P. 388. 4. *Cumbu* (**Pennisetum typhoideum**) straw	7·07	8·04	37·63	1·34	43·65	1·94	·33	1:44
P. 336. 5. *Varagu* (**Paspalum scrobiculatum**) straw.	8·71	10 05	28 84	2·51	47 60	1·97	·31	1:42
OTHERS.								
6. Wheat straw (English).	14·3	4 60	44·00	1·50	32·6	3·00	...	1:27
7. Wheat straw (American).	8·78	4·16	44·99	1·29	37·33	3·45	...	1:25
8. Maize straw (American).	9·57	5·23	29·97	1·10	49·17	5·02	...	1:16
9. Barley straw dead-ripe (English).	15·20	4·26	66·54	1·36	8 21	4·43	...	1:17
10. Oat straw (English).	11 56	8·18	28·57	47·97		3·01	·71	1:25
11. Oat straw (American)	8·74	4·81	41·52	2·22	38·89	3·82	...	1:23·5

by Benson and Van Geyzel. | FODDER.

Apparent poverty in albuminoids.

The first point to observe is the apparently extraordinary poverty of the Indian straw in albuminoids. This brings down the "albuminoid ratio" in all cases to a figure much below that given for any English or American fodders That this is misleading will, however, be evident, if the nitrogen found in the non-albuminoid compounds be calculated in the usual way into albuminoids and the nutritive relation be worked out on the result as shown in the margin. The results are then, except in the solitary case of the analyses of oat straw where the non-albuminoid nitrogen is separately given, generally much more favourable as to the quality of Indian fodders. In comparison with the English and American straws shown in the table, and judged by the figures representing the "albuminoid ratio" (*i.e.*, the *total* nitrogen being regarded as albuminoid), the South Indian fodders examined do not appear to be inferior; they also compare favourably in respect of the total amounts of nutriment contained in them as shown on the margin, *viz.*, the sum total of the albuminoids, the starch and the starch equivalent of fat, excluding the fibre, which is in this case usually regarded as non-assimilable. What proportion of the total nutriment is actually assimilable being unknown, it would be unsafe to condemn these fodders, though regarded absolutely as food in the light of their albuminoid ratios, the analyses show that these fodders, on which South Indian cattle mainly depend, are not of high value. Of the fodders generally obtainable, *ragi* straw appears to be the best, while *varagu* and *cumbu* straw are but little inferior to paddy straw, and *cholum* straw is the worst.

Straw.	Albuminoids.	Albuminoid ratio.
1. Paddy .	4·06	1:19
2. Cholum .	3·26	1:27
3. Ragi .	4·41	1:18
4. Cumbu .	4·02	1:21
5. Varagu .	3·93	1:21

Straw.	Total nutriment.
1. Paddy . .	47·8
2. Cholum . .	59·4
3. Ragi . . .	54·7
4. Cumbu . . .	48·8
5. Varagu . . .	57·3
6. English wheat .	39·0
7. American do. .	43·7
8. Do. maize .	56·7
9. English barley (dead-ripe) . .	15·7
10. English oat . .	50·9
11. American oat .	47·8

COMPARATIVE VALUES.

Ragi.
Paddy.
Varagu.
Cumbu.
Cholum.

Probably the most instructive comparison is one which may be instituted between *cholum* and maize (American). It will then be observed that the proportion of dry matter in both is nearly the same as are those of fibre and other carbo-hydrates, excepting fat, in which *cholum* fodder is richer, and this taken in connection with the comparative poorness of the latter in albuminoids gives it only a ratio of 1 : 54, or of 1 : 27 if all the nitrogen present be taken as albuminoids, against 1 : 16 for maize in America. In *cholum*, as in all the other Indian fodders, mineral matters are shown as existing in a far larger proportion than in the English and American straws, but whether this be due to greater care being observed in harvesting the latter is not known. The enormous proportion of ash in paddy straw is very noticeable, whilst that found in *ragi* and *varagu* is also very large.

RICE.
O. 271.

Turning now to the detailed statement of results given below, some peculiarities will be noticed. Of the samples of paddy straw analysed, the richness of No. 3 (p. 5), from Madura, in albuminoids, and the poverty of No. 4, from Tanjore, in the same constituent, are noticeable. The same Madura sample was very rich in fat also, and has an albuminoid ratio of 1 : 22 against 1 : 85 for the Tanjore sample. The variations in the proportion of non-albuminoid nitrogen found, probably point to the different

stages of ripeness at which the crops were cut. A high proportion of ash in the case of paddy straw may, perhaps, be partly attributed to deposition of particles of soil on the straw from the irrigation water in which the crop grows, although it is known that paddy naturally contains a large amount of silica in its composition.

CHOLUM. S. 2440.

Without further information as to the digestibility of the straw, it is not possible in reference to the analysis of *cholum* to explain the high repute in which that fodder is held, although, in respect of the total amount of nutriment contained in it, it is superior to all the other straws which have been examined. The best sample of which a complete analysis is available is that of black *cholum*, from Madura, in which the albuminoid ratio is 1 : 42. In the others it is considerably lower, but the variations in composition are not great.

RAGI. E. 182.

The samples of *ragi* straw are from two districts—Salem and Nellore—and exhibit considerable variations in nutritive value. The averages for the two districts do not show much variation, except that the Nellore samples contained nearly one eighth more mineral matter than the Salem ones. In individual samples the variations were, however, large, both in respect to ash and moisture, whilst the albuminoid ratio varied between about 1 : 27 and 1 : 47.

CUMBU. P. 388.

The samples of *cumbu* straw analysed were received from Salem and Cuddapah and present a tolerably constant proportion of moisture, but the mineral matters vary considerably from as low as 6·6 per cent. up to 11 per cent. of the weight. In respect to nutritive matters, moreover, the variation is considerable, the Salem samples giving an albuminoid ratio of 1 : 39, and those from Cuddapah 1 : 49. The Cuddapah samples also show a considerably higher proportion of woody fibre, which points to later harvesting, as does also the smaller proportion of non-albuminoid nitrogen. In both districts the variation between individual samples is considerable, for, whilst No. 37, from Pullampet in Cuddapah (a sample with a small proportion of ash), shows a nutritive ratio of 1 : 39, the Salem average, No. 39, from Badvel, has a ratio of only 1 : 66; and whilst No. 30, from Dharmapuri in Salem, shows a ratio of 1 : 48, No. 29, from Tiruchengod, has a ratio of 1 : 31.

VARAGU. P. 336.

The samples of *varagu* straw analysed were received from Tanjore and Kurnool. Those from the former district are remarkably uniform in composition, except as regards the proportion of moisture and fat found in them, the more moist sample showing a low proportion of fat. The average of these shows a nutritive ratio of 1 : 36. The samples from Kurnool are more varied in composition, but taken together give a nutritive ratio of 1 : 49 only, one of them going as low as 1 : 54. All the samples are less rich in albuminoids than the Tanjore samples, but also contain less non-albuminoid nitrogenous matter. In regard to fat they show great variations, as they also do in the proportion of fibre found in them; Nos. 43 and 44 being very free from fibre and No. 45 showing a comparatively large proportion of that substance.

No.	District.	Taluk.	Moisture.	Ash.	Woody fibre.	Fat.	Albuminoids.	Nitrogen in non-albuminoid compounds.	Other nutritive matter free from nitrogen.
		PADDY STRAW—(Oryza sativa, *Dict.*, O. 271.)							
1	Salem	Tirupatúr . . .	6·200	15·933	20·000	2·858	4·000	...	51·009
2	Madura . . .	.....	4·838	13·200	28·177	3·164	6·200	...	44·421
3	Do.	.....	8·628	14·800	29·170	3·600	3·500	·280	40·022
4	Tanjore . . .	Kumbakónam . .	8·502	18·000	31·012	1·433	·875	·140	40·038
5	Chingleput . . .	Tiruvallúr . . .	7·000	19·000	28·967	2·173	1·412	·420	41·028
6	Kistna	Guntúr . . .	6·278	15·600	32·771	1·542	1·412	·490	41·907
7	Do.	Répalle . . .	8·000	18·900	31·415	1·490	1·750	·280	38·165
8	Salem	Úttankarai . . .	10·326	14·938	26·814	2·806	1·750	·560	42·726
		Average of Nos. 3—8 .	8·122	16·873	30·025	2·187	1 783	·362	40·648
		CHOLUM STRAW—(Sorghum vulgare, *Dict.*, S. 2440.)							
9	Madura . . .	Pudugai lands, Dindigul	7 635	6·842	29·439	3·340	3·500	...	49·244
10	Do. (Black cholum) .	.....	9·667	7·250	32·189	2·723	2·000	·240	45·931
11	Kistna	Nandigáma . . .	7·771	6·400	30·733	3·728	1·312	·210	49·846
12	Kurnool . . .	Rámallakót . . .	6·753	7·600	29·863	2·977	1·531	·315	50·961
		Average of Nos. 10—12 .	8·064	7·083	30·928	3·143	1·614	·255	48·913

F. 672.

Analyses of Fodders—continued.

No.	District.	Taluk.	Moisture.	Ash.	Woody fibre.	Fat.	Albuminoids.	Nitrogen in non-albuminoid compounds.	Other nutritive matter free from nitrogen.
		RAGI STRAW—(**Eleusine Coracana**, *Dict.*, E. 182.)							
13	Salem "Per" ragi	.....	11·693	8·200	28·595	2·125	2·625	·280	46·482
14	Do. "Thuval" ragi	.....	11·130	12·300	26·363	3·250	2·187	·350	44·420
15	Do.	Hosúr	7·716	14·000	27·511	2·914	1·750	·280	45·829
16	Do.	Dharmapuri	6·866	8·800	32·112	2·162	2·187	·350	47·523
		Average of Nos. 13—16.	9·351	10·825	28·645	2·613	2·187	·315	46·064
17	Nellore	Gúdúr	9·287	15·400	25·814	2·163	1·750	·420	45·166
18	Do.	Rápúr	8·823	8·600	32·083	1·517	1·750	·280	46·947
19	Do.	Venkatagiri	12·809	13·800	22·782	3·558	2·625	·420	44·006
20	Do.	Nellore	14·188	13·800	24·568	2·160	2·625	·420	42·239
21	Do.	Atmakúr	10·034	14·800	27·905	1·645	1·750	·280	43·586
22	Do.	Kávali	8·922	12·200	31·025	1·622	2·187	·350	43·694
23	Do.	Udayagiri	12·653	15·400	25·187	2·862	2·187	·350	41·361
24	Do.	Kandukúr	9·555	14·400	29·440	2·026	2·187	·490	41·902
25	Do.	Kanigiri	8·315	14·200	28·427	2·114	2·625	·420	43·899
26	Do.	Ongole	9·607	11·200	30·726	1·683	2·187	·490	44·107
		Average of Nos. 17—26.	10·419	13·380	27·796	2·135	2·187	·392	43·691
		Average of Nos. 13—26.	9·885	12·102	28·221	2·374	2·187	·353	44·878

Analyses of Fodders—continued.

No.	District.	Taluk.	Moisture.	Ash.	Woody fibre.	Fat.	Albuminoids.	Nitrogen in non-albuminoid compounds.	Other nutritive matter free from nitrogen.
		CUMBU STRAW—(Pennisetum typhoideum, *Dict.*, P. 388.)							
27	Salem	Tirupatúr . . .	6·175	6·353	34·170	1·835	3·475	...	47·992
28	Do.	Námakal . . .	8·342	6·700	32·482	1·763	2·187	·490	48·036
29	Do.	Tiruchengód . . .	7·786	10·200	36 215	1·476	2·625	·420	41·278
30	Do.	Dharmapuri . . .	6·644	9·000	35·361	1·154	1·750	·420	45·671
31	Do.	Hosúr	5·092	6·600	38·186	1·867	1·750	·280	46·225
32	Do.	Krishnagiri . . .	6·281	9·200	36·456	1·196	2·187	·350	44 330
33	Do.	Atúr, red loam . .	7·659	11·000	31·543	1·273	2·187	·350	45·988
34	Do.	Atúr, red sand . .	8·068	7·000	37·639	1·293	2·187	·350	43·463
35	Do.	Úttankarai . . .	9·602	6·618	33·162	1·972	2·187	·350	46·109
		Average of Nos. 28—35.	7·434	8·290	35·131	1·499	2·133	·376	45·138
36	Cuddapah . . .	Cuddapah . . .	5·739	8·600	40·304	1·357	1·750	·280	41·970
37	Do.	Pullampet . . .	6·051	6·600	42·534	1·144	2·187	·350	41·134
38	Do.	Sidhout . . .	7·097	8·600	39·865	·952	1·750	·280	41·456
39	Do.	Badvél . . .	6·658	6·600	39·376	1·461	1·312	·210	44·383
40	Do.	Ráyachóti . . .	8·007	8·600	38·580	·942	1·750	·280	41·841
		Average of Nos. 36—40.	6·710	7·800	40·132	1·171	1·750	·280	42·157
		Average of Nos. 28—40.	7·072	8·045	37·632	1·335	1·942	·328	43·648

FOOD. South Indian Fodders by Benson and Van-Geyzel.

ANALYSES of Varagu.

Analyses of Fodders—concluded.

No.	District.	Taluk.	Moisture.	Ash.	Woody fibre.	Fat.	Albuminoids.	Nitrogen in non-albuminoid compounds.	Other nutritive matter free from nitrogen.
		VARAGU STRAW—(Paspalum scrobiculatum, *Dict.*, P. 338.)							
41	Tanjore . . .	Kallimodu . . .	9·174	11·000	29·709	3·249	2·187	·350	44·331
42	Do. . . .	Telungakudikadu . .	10·484	11·200	29·567	1·313	2·187	·350	44·899
		Average of Nos. 41 & 42.	9·829	11·100	29·638	2·281	2·187	·350	44·615
43	Kurnool . . .	Cumbum, first sort .	8·143	8·200	23·342	3·505	1·750	·280	54·780
44	Do. . . .	Do. second sort .	8·141	9·200	26·536	2·865	1·750	·280	51·228
45	Do. . . .	Márkápur . . .	6·519	9·600	31·248	1·863	1·750	·280	45·740
		Average of Nos. 43—45.	7·601	9·000	28·042	2·744	1·750	·280	50·583
		Average of Nos. 41—45.	8·715	10·050	28·840	2·512	1·969	·315	47·599

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(Agricultural Series, No. 2.)

THE

AGRICULTURAL LEDGER.

1892—No. 2.

SEEDS—CLASSIFICATION OF; SELECTION; PRESERVATION; DISTRIBUTION; ETC.

[*Dictionary, Economic Products, Vol. VI., Pt. II.*, S. 1038 a.]

SEED DISTRIBUTION IN THE UNITED STATES:

Abstract of a paper by the ex-Superintendent of the Seed Division, United States.

SEED SELECTION.

1. OBJECT OF DISTRIBUTION OF SEEDS.

Good seed means vital seed, fixity of type, fecundity of product, and adaptiveness to locality. The primary object of distribution of seeds by the Department of Agriculture, to those engaged in agricultural pursuits, is to give increased value to production by the introduction and distribution of improved varieties that will increase the annual average yield of the staple crops of grain and vegetables, and more rapidly, and more generally, introduce the very best varieties of seeds into new states and territories, as well as into the older ones, where the annual average crop is being diminished by seeding with unselected and inferior seed. The system of general distribution by the Government was established that the merits of well-bred, fully ripened, perfect seed could be tested in different localities and soils, so that both the quality and quantity could be improved and increased. The constantly increasing number of requests for Department seeds is the best evidence that they are of value. The Seed-Division is not a mere seed warehouse, but the annual reports teem with interesting facts of practical value, and show what new varieties of seeds have been distributed and the results effected.

2. SEED DISTRIBUTION.

The seeds distributed consist, for the most part, of field seed, and, to a smaller extent, of vegetables, flowers, and textiles (cotton, rami) seed. The average weight of seeds distributed each year from June 30th, 1883, to June 30th, 1888, was 400,000lb or 200 tons.

3. VALUE OF SEED AND PLANT DISTRIBUTION TO THE COUNTRY.

Result.

The value of the distribution is testified to by the reports of Commissioners and others, from which the following extracts are selected :—

"The dissemination of Sorghum and Imphee seed has been worth millions of dollars to the country.

Profit.

"The increased production of wheat, oats, and grasses by reason of the distribution of new and improved seeds pays more than ten times the whole amount expended by the Government in this Department.

"The beneficial results arising from the introduction of the Fultz wheat, sent out by the Department, has every year, since its dissemination, more than paid the whole cost of the Department."

SEED Selection. **Seeds—Classification of;**

A great number of economic plants and fruits have been distributed, and the introduction of the Bahia orange is said to have been worth, to California alone, more than all the Department of Agriculture has ever cost the country.

4. Method of purchasing seeds.

Quality.

Prior to March 7th, 1889, the method of purchasing seeds was that of receiving bids from responsible seed-growers and seed firms, who were required to give a guarantee that the seeds furnished would not only be true to name and of good germinating quality, but also cleaned with extra care, so as to be free from weeds, seeds, or larvæ of injurious insects. Since September 1885, all seeds received by the Department are tested not only in a seed-tester but in the plant-propagating houses, and, when necessary, by either the entomologist or botanist. If the guarantee is not verified, they are promptly rejected. The average germination of all seeds accepted has been 93 per cent. When, however, the percentage in those varieties which are somewhat difficult approximates 75 to 85 per cent., the seed is regarded as being of sufficient value to warrant its purchase and distribution. In the test of flower seeds, the percentage usually ranges somewhat lower.

The present method of purchasing seeds is that of employing a special purchasing agent, who visits different sections of the country, inspects the product of which seeds are offered to the Department, etc.

5. Seed-testing apparatus.

Testing.

The seed-testing apparatus now in use consists of two heavy block-tin pans, 17 inches in length, 12 in width, and $2\frac{3}{4}$ in depth, painted inside and out. Two and one-eighth inches from the bottoms of the pans a ledge, $\frac{1}{2}$ inch in width, is soldered to the sides. Upon the ledge rest brass rods, which support V-shaped pockets made of unbleached thin muslin, each $10\frac{1}{2}$ by $2\frac{1}{2}$ inches. The bottoms of the pans are covered to the depth of half an inch or more with water, so that the lower ends of the pockets come in contact with it and the seed is kept moist by capillary attraction. The seeds to be tested, numbering 25, 50, or 100, are placed within the muslin pockets, and moistened. Each pan is then covered with a heavy pane of glass and placed near a window. The date of commencement and conclusion of the test, and per cent. of seeds that germinate, are noted.

For use on the farm any comparatively shallow pan will answer the purpose. The ends of the rods can rest on the sides of the pan, and an ordinary pane of glass can be used as a cover. When the roots penetrate the pockets, they can be subdivided with a pair of scissors, and the plants transplanted with the muslin.

By this method not only can the purchase of worthless seeds be obviated, but, if already purchased, the proper amount of seed to sow to the acre may be definitely determined, even though a quarter or third of the seed possesses no vitality whatever.

6. Methods of distribution.

Under this heading the following suggestions are noted:—

1. That members of Congress should set apart a considerable portion of their quota now distributed to individuals to be divided between the State, country, and local agricultural and horticultural societies.

2. That all members of societies who receive seeds from the Department for experimental purposes should return to the society at least as much as the quantity received, if experiments turn out favourably.

3. That each Congressman, who resides in an agricultural district, should select six or twelve intelligent farmers and divide his quota of field seeds equally between them, with the agreement on their part that after the second year's crop is harvested, one-half of it shall be sold, at the prevailing market price, to farmers and planters who reside within the district, and that a record of such sales, with the name and address of the buyer, be sent to the Secretary of Agriculture.

The following Dictionary articles out of many others may be consulted in connection with the subject of State selection and distribution of superior qualities of seed :—

Gossypium, *Vol. IV.*, G. 447-48.

Indigofera tinctoria, *Vol. IV.*, I. 226.

Nicotiana Tabaccum, *Vol. V.*, N. 108 (*particularly remarks on page 366*).

Oryza sativa, *Vol. V.*, O. 263.

Papaver somniferum, *Vol. VI., Pt. I.*, P. 188-212.

Saccharum, *Vol. VI., Pt. II.* (*section on Improvement of Seedlings*), S. 148-55, *more especially* S. 155.

Sheep and Goats, *l. c.*, S. 1322-72, *particularly* S. 1347-48.

Zea Mays, *Vol. VI., Pt. IV.*, Z. 51-56.

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AGRICULTURAL LEDGER.

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SOLANUM TUBEROSUM.

[*Dictionary, Economic Products, Vol. VI., Part III.*, S. 2340.]

POTATO PRESERVATION:

Extract from Bulletin of the French Minister of Agriculture.

THE Bulletin of the French Minister of Agriculture, No. 1, March 1891, contains a recipe by **M. Schribaux,** Professor of the Agricultural Institute of France, for the preservation of potatoes for a prolonged period, which it might be worth while to try experimentally in India. "The potatoes," it is said, "should be steeped in water, diluted with sulphuric acid, in the proportion of 2 per cent. of sulphuric acid, for ten hours, and then, after being wiped, stored as usual. The dilution is not weakened by the operation, and can be used for successive steepings as long as it lasts."

This method, even if found efficacious and practical, could not of course be applied to potatoes intended to be preserved as seed. In the Dictionary article on **Solanum** (page 267) particulars will be found of the system followed in Bengal to preserve seed potatoes.

(Agricultural Series, No. 3.)

THE

AGRICULTURAL LEDGER.

1893—No. 1.

SILT DEPOSITS.

[*Dictionary, Economic Products, Vol. VI., Pt. III.*, S. 2204 a.]

SILT AND FERTILIZATION OF SOILS BY INUNDATION.

Extract from "Irrigation in Southern Europe," by COLONEL SIR COLIN SCOTT-MONCRIEFF, K.C.M.G., C.S.I.

Fertilising water.

In the valley of the Moselle, in the Département des Vosges, a very interesting and important description of irrigation is carried on to an extent never heard of elsewhere, and which I was very glad to have an opportunity of visiting. The irrigation is confined to meadows, but the system differs entirely from that of the *marcite* pursued in North Italy. In the case of this latter, much stress is put on the temperature of the water being in winter higher than that of the external atmosphere; the land irrigated is of the average quality for cultivation, and the species of cultivation itself is found so exhaustive that the land requires to be constantly replenished with manure. In the irrigation now to be described, on the other hand, the essential condition of the water is that it shall carry with it a fertilising deposit, irrespective of its temperature. The land irrigated need be no better than a bed of stones, and the operation, so far from impoverishing the soil (which indeed it would be impossible to do), makes it richer every year.

Reclamation of waste.

In the Italian system, on average land with abundance of manure and water, the produce of the five annual crops is 24 tons of grass per acre. In the Moselle valley, *on land originally absolutely barren and worthless, and with no manure save the alluvial matter deposited by constant and even more abundant irrigation*, the produce of the two yearly crops after a few years attains to 4 tons of grass per acre. The following information on this subject is derived from my personal observations, and from what I learned from the obliging Engineer, who explained to me the system, and also from an interesting paper by M. Foltz, Engineer of the Ponts-et-Chaussées, to be found in the Annals of that Department for 1849.

The River Moselle takes its rise in the granite and forest-covered mountains of the Vosges Alps, and flows at a high velocity in a north-west direction, past Epinal, the chief town of the department. Here its minimum discharge is from 350 to 450 cubic feet per second. When I saw it, early in February, it must have been carrying far more water than that, while it

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looked most beautifully clear and transparent, running over a bed of smallish boulders and green-water weeds. It seems, however, that this extreme purity is only apparent, and that at all seasons it leaves on the stones not directly washed by its current a hardish brown crust of alluvial matter. Above Epinal the course of the river is well defined and regular; below that point it used to flow over a broad gravel bed in a number of separate streams continually changing. A scanty crop of miserable pasturage used sometimes to spring up on the best parts of this broad channel; the rest was quite barren. This worthless strip of boulders and gravel is now being transformed into extensive stretches of green meadow, yielding plentiful crops, and at the same time confining the river within a permanent and defined bed in a way no series of expensive embankments could easily have effected. The result of river embankments has been too often to raise the bed year by year, so that they too require to be raised. In the Moselle valley, on the other hand, the floods are allowed to flow almost unchecked over the whole of their old channel; but, when they retire, they leave good instead of mischief behind them, and resume the same course as they did before they rose.

History.

Construction.

This work was commenced by two brothers, Messrs. Dutac, in 1827, by their buying 50 acres along the left bank of the river's bed at La Gosse, a little below Epinal. At the head of this a rough boulder-dam was thrown across the river, turning about 70 cubic feet per second of its waters into a channel taken along the left of the estate. To this was given a gentle slope, which soon raised it above the river, and, when I visited it, the whole of the land lying between the river and the canal was a fine green meadow. The masonry works on the canal are all of the simplest kind, and require no remark save to notice this simplicity. The process then is as follows:—Below the dam there is erected an embankment at such points as are required, high enough to prevent the full current of the river from anywhere sweeping over the land to be reclaimed, but not at all intended to keep it from being flooded. From the main canal are taken out little branches, and the land to be irrigated by them is carefully levelled in a succession of parallel ridges and valleys running at an angle to these branches. About every 25 feet along their course are little openings, admitting a stream of water about 6 inches wide and half as deep, which flows along and overflows a channel made on each ridge, running over the slopes into a similar channel in the depression below. Along this it runs into a catch-water drain, which collects all these little separate streams, and a little farther down commences to give the water out again to irrigate a fresh piece. Sometimes the irrigating streams are made in pairs, back to back; sometimes they run singly.

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Method of irrigation.

The gravelly bed is then sown with grass seed (without making any attempt to clear it of stones) and the irrigation is at once commenced. A light deposit of mud forms slowly, every flood increases it, the irrigation is carried on incessantly, and the grass soon begins to sprout. I saw some land belonging to the Municipality of Charmes which had only been prepared the previous August, but was showing a marked difference in appearance. After a year the meadow begins to yield a return, and after three it is in full vigour, from which it never recedes. And those meadows which were first begun in 1827, and have never been ploughed up and renewed or manured, are yielding as good returns now as ever they did. At first the operation must be conducted with great care and judgment. If the water is let on with too much force, it is apt to carry away the seed and

destroy the young vegetation. If it is suspended, one or two hours of bright sunshine will injure the plant. The best times for sowing are in the moist months of spring and autumn. **Method of irrigation.**

At first the supply of water should be incessant, but it may be safely reduced when the plant has acquired strength, and I was told that, if watered one day out of four, the grass would not suffer. M. Foltz, however, recommends that every alternate day the land should be irrigated. Grass unwatered for five or six days loses much of its quality. The silt deposit proceeds much faster at first when the water sinks directly through the gravel, which acts as a filter. By degrees this filtration causes a nearly impermeable bed, through which very little of the water escapes, and just so much the more flows off by the drainage lines, and flows off without having entirely divested itself of its particles of mud. Were it not for this the meadows would rise higher each year, and soon be above the water's reach, but it is found that after a few years there is no sensible change in their level, and what is deposited by fresh silt only makes good what is consumed on the vegetation.

For the ten or fifteen days before cutting the grass, the irrigation should cease to dry the soil and help to mature the grass. The first hay crop is at the end of June; the second, which is of an inferior quality, and only given to oxen, not to horses, is cut in September. Sometimes they have a third. In a good meadow each crop ought to be about 2 tons per acre. The price of hay is from 32*s.* to 40*s.* per ton.

It is hard to measure the quantity of water required for this style of irrigation, for it must depend on what proportion of silt it is necessary to have. As it constantly flows, so it runs off, and may be used again and again; but each time it will become clearer and have less fertilising powers. Supposing it is only used once, M. Foltz recommends 100 litres per second as the allowance per hectare; that is, ·7 acre per cubic foot, and this seems considered about the right amount, supposing that the land is always to be kept under water.

After stating the quantities used in different places, which varied from 70 litres to 130 litres per second per hectare, M. Foltz adds his opinion that "on gravelly soil one ought to try to obtain 100 litres per second and per hectare; and, if circumstances obliged it to be restricted, one may adopt two turns, which reduces by half the volume of water necessary for all the surface. But below 40 or 50 litres one would be forced to increase the number of turns, and irrigation would be perhaps still possible, but the result would not be so satisfactory." It need not be remarked that the quality of the water and of the silt it carries with it is a matter of the first importance in irrigation of this description. **Quantities of water.**

The only time when irrigation quite ceases is during frost, which they do not much dislike, as it kills off the moles and other vermin. The meadows are none the worse, but the better, for being three or four days completely submersed under floods, and they do not often last longer.

Encouraged by their complete success at La Gosse, the Messrs. Dutac formed companies and raised capital, which enabled them to carry on the work on a much larger scale; and to them and to an enterprising gentleman, M. Naville, of Geneva, belong now extensive estates in the bed of the river from Epinal to the limit of the department. In 1847 the area thus reclaimed was 2,000 acres, and it is much increased since then. **Extension.**

I had an opportunity of inspecting a piece of ground of 128 acres, in the village of Chamagne, being prepared for this sort of cultivation. As it was well raised above the river, out of all reach of floods, and covered **Cost.**

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with a short grass, it was not in such a hopeless state to begin with as many other places. And on this account it had been resolved to save the heavy expense of a dam across the river, and to take the water instead second-hand from the escape channel at the foot of an estate of 270 acres belonging to M. Naville, getting thus of course less alluvial deposit, and in short an inferior article at a cheaper rate. The little canals for this area are nine in number, with a uniform slope of 1 in 2,000, provided at intervals with masonry falls of 1·64 feet in height, to enable them to keep near the surface of the land, the slope of which is 1 in 400. The depth of water in these channels varies from 3·28 feet to 4·92 feet, and in the lesser channels from 1·2 to 1·9 feet. The side slopes are 3 in. base to 2 in. height. The widths of bed have been calculated for a discharge at the rate of 100 litres per second per hectare. The estimated cost of preparing this land per acre is as follows:—

	£	s.	d.
Constructing the main and minor channels at the rate of 11*s.* 2*d.* per 1,000 cubic feet earthwork.	5	5	9
Masonry works, falls, and *prises*, with sluices .	6	13	6
Levelling land, opening little distribution courses and drains	4	0	10
Sundry expenses	1	12	5
Total cost per acre .	17	12	6

In this, it must be remembered, nothing has been spent on a dam over the river. The usual allowance, including a dam, is about £28 per acre.

Adoption in India.

The immense consumption of water for this sort of irrigation would make it, I fear, generally inapplicable to the condition of things in India. I have seen places, however, where it might well be applied in the hill-valleys of the Himalayas, but they are so extensively cultivated already for rice, that little attention would likely be paid to the growth of hay until things are very different from what they are at present. It should be noted that this consumption of water does not really take much out of the river that is not restored to it by the escape channels and by filtration; so that M. Foltz asserts his belief that "the quantity of water absorbed by irrigation is less than that which is carried off by evaporation when a river flows by several branches over gravel exposed to the sun."

[The following Dictionary articles among others may be consulted, in connection with the above brief notice of Sir Colin Scott-Moncrieff's paper:—

Mineral Manures, *Vol. V.*, **M. 255.**
Oryza sativa, *Vol. V.*, **O. 310, etc., etc.**
Reh, *Vol. VI., Pt. I.*, **R. 67.**
Sand-binding Plants, *Vol. VI., Pt. II.*, **S. 774.**

It may fairly be said that the Natives of India are by no means ignorant of the principle of reclamation or formation of land by the

system detailed above. No large public measures of the nature discussed have in recent times, however, been undertaken. Within the hills the valleys are, as a rule, cut too deep, and the torrents of the rainy season are too great, to allow of silt obstruction works on a very extended scale. The water literally rushes to the plains with irresistible velocity during certain months, and the channels of these great rivers subsequently become sandy and stony wastes in which not a drop of water is to be found. The aboriginal tribes, however, regularly retard the smaller streams and spread the water over large tracts of carefully-terraced land in a manner which for their means and necessities could scarcely be improved on. It is, for example, by no means unusual for the inhabitants of the lower hilly tracts to *bund* the streams by trees and other materials, and thus cause the water to form temporary lakes or shallow basins in which silt deposits freely take place. Terrace after terrace of this nature may be seen, and fertile fields, as it were, thus built up within the valleys.

The subject raised in the above extract is, however, very interesting, as it deals with a question which may be said to resolve itself into two main issues:—(*a*) prevention of the destruction of land though the erosive action of water; and (*b*) the actual formation or fertilisation of lands through the agency of water. The former subject is intimately associated with the reclamation of land from permanent inundation, from sand-drifts, and from salt efflorescence, while the latter passes into the wider question of seasonal inundation. In the passage to which reference has been made under **Oryza** it will be found **Mr. C. B. Clarke** contends that the rice lands of Bengal are mainly if not wholly watered by rain inundation, and that under such conditions there is no silt deposit. In this respect, therefore, the Gangetic basin would be quite dissimilar from the Nile valley. In Upper India, however, the agency of canals and rivers has been largely employed in the production of fertile silt deposits.—G. W.]

(Vegetable Product Series, No. 3.)

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1893—No. 4.

SOLANUM TUBEROSUM, *Linn.*

[*Dictionary, Economic Products, Volume VI., Part III.*, S. 2330.]

POTATO DISEASE.

Summary of Reports by Mr. CAPPEL, *Officiating Director, Land Records and Agriculture, Bombay:*

Also a Note by the Editor on the Life-history of PHYTOPHTHORA INFESTANS.

THE following note on a fungoid disease which has affected the potato crop in the Bombay Presidency and other parts of India, is a *précis* of the reports issued by Mr. Cappel, Officiating Director, Land Records and Agriculture, Bombay.

Extent.

Early in 1891 a potato disease, which has caused heavy loss to the cultivators and a marked deterioration of quality in the potatoes sold for consumption, was brought to notice in the Bombay Presidency. It has established itself throughout the Bombay Presidency, including Gujarat, and has been found on the Nilgiris, at Bangalore, and in Bengal.

Appearance.

The cultivators call it the *bángdi* or ring disease, owing to the appearance of a dark ring easily visible in the substance of the tuber on section. Unsound and (apparently) sound potatoes are found in the same field, but the whole crop is in such cases probably affected. The first *outward* symptom is a withering of the green top, with arrest of the growth of the tuber. The diseased crop, when dug, is found to be greatly undersized throughout; many tubers are rotten and putrid; others show, by a small livid spot, where putrescence is about to set in. The whole potatoes are eatable when fresh, but rot away in storage.

Dr. Cunningham's opinion.

In a provisional note on the ætiology of the disease, Dr. Cunningham stated that, so far as he could ascertain, it is essentially due to an invasion of the vascular bundles of the base of the haulm by fungal mycelium, which is to be found in all the elements of the bundles, and in special abundance in the larger vessels, which are in many places absolutely plugged by dense sclerotial masses of filaments. In a further note Dr. Cunningham stated that microscopical investigation had led him to believe that the lesions of the tuber are of a secondary nature, that the primary lesions are those in the haulms, and that it is the disturbance of nutritive conditions determined by these which occasions the pathological changes in the tuber. "I should," he says, "certainly be inclined to believe that the disease is maintained not by the use of diseased tubers as such, but as the result of planting either diseased or healthy ones in soil contaminated by containing portions of the haulms with their mycelial and specially their sclerotioid contents."

In a letter to the Editor Dr. Cunningham expresses a wish that, in sub-

mitting specimens of potato blights for examination, entire plants, and not merely tubers, should be sent. The Deputy Commissioner, Khasi and Jaintia Hills, sent him entire plants in dry moss in a well-ventilated box, and he was thereby able to determine at once that the disease was due to **Phytophthora Perinosporæ.**

The diagnostic symptoms of the disease, prior to the appearance of the characteristic ring in the tuber, are said to be the sudden wilting of the green top, and the antecedent brown discoloration of the fibro-vascular bundles of the haulms discoverable on section.

The disease develops most a little below the soil surface, and extends downwards as well as upwards in the stem. When pulled, the stem breaks off at the main point of disease-development, and hence as many "germs" would be left in the soil as would be removed.

Mr. Mollison's experiments.

The practical result of the Khed (Poona district) experiments of the past season was to show that certain varieties of imported seed* can and do resist infection in a marked degree. Mr. Mollison's experimental results fully established this, and the cultivators of the district were eager to obtain seed from the new stocks at almost any price. Unfortunately it is difficult to keep the cold-weather seed till the following winter because of its tendency to sprout in the monsoon months, and it becomes necessary to grow a crop during the rains to provide seed for the main-crop cultivation of the next cold weather. This rain-crop is not always as sound in cultivation as the dry-season produce, and here we find another cause tending to the deterioration of all stocks after they have been grown in this country for any length of time.

Remedies.

The "Bouillie Bordelaise" † treatment of the land *before sowing* succeeded in a very considerable degree, and there can be no doubt that flushing diseased land with the copper sulphate solution in the manner adopted in these experiments is specific as regards all disease germs which it reaches. It has been found in a large degree to protect sound plants from infection and to prevent the spread of disease from one plant to another. The treatment with caustic lime and soot was inconclusive, because the imported seed proved so robust that the failure of the disease to make headway cannot with certainty be attributed to the treatment adopted.

The mode of application of the sulphate of copper was as follows. The salt was first converted into a concentrated solution, and was then added to the irrigation water as it was raised from the well by môt, a measured quantity of the solution being added to each bagful of well-water as it was discharged into the receiving trough at the lip of the well. The salt was thus applied at any desired rate per acre. The hardness of the well-water is probably due to carbonate of lime, and it was noticed that, when the copper

* The best variety tried, for general cultivation, was Sutton's "Early Regent," which could have been sold in any quantity for seed purposes. Sutton's "Windsor Castle" came next. Sutton's "Triumph" and Sutton's "Perfection" each succeeded admirably, and are beautifully-shaped varieties which cook well. Apparently, the newly-imported English seed and the Kumaon-grown English varieties resisted the disease independently of treatment, at any rate to a very large extent.

† *Copper sulphate solution with quicklime* (Bouillie Bordelaise) for 1 acre:—

45lb sulphate of copper,
22½lb quicklime,
220 gallons of water (2,200lb).

The sulphate should be dissolved by hanging it in a coarse cloth or basket in water contained in a wooden vessel. Hot water acts more quickly. The quicklime is slaked in a separate tank, and then stirred into a fine gruel with added water. This should be passed through a sieve into the solution, well stirred, and the remaining water added.—[*Report, 1892.*]

sulphate solution was added, a dense precipitate formed, which was carried to the field by the flow of the water. This precipitate was probably hydrated oxide of copper, a compound which destroys fungoid germs, but is harmless to vegetable tissue. If this assumption be correct, the change in the constitution of the liquid was advantageous, since sulphate of copper has an injurious effect on vegetation.

Good seed.

The somewhat unexpected degree of success with the imported seed has prevented any very clear differentiation being arrived at with respect to the methods of cultivation followed. The ridge and furrow system, however, has not been proved to have the full advantage as at first expected. This is probably due to the more rapid growth and maturing of the tubers in this country, the crop being ready in 14—15 weeks as against at least 20 weeks in Europe. The bed system with its superabundance of surface moisture seems to enable the plant to effect the more rapid assimilation of food necessary under Indian conditions. But, on the other hand, it is extremely probable, as pointed out by Mr. Mollison, that the constitution of the plant is unfavourably affected by this luxuriance of growth, and is more prone to disease in consequence.

The lesson so far learnt is that the disease may be largely checked by the use of the copper salt, but that reliance must chiefly be placed on the distribution of robust seed of the varieties which have been found most successful. It has also been found that the small-cut sets used by natives induce weak growth, and that large-cut sets or, better still, medium-sized potatoes planted whole produce more vigorous seedlings. Great interest has been taken by Native cultivators in the experiments, and they have shown themselves ready to take large quantities of seed at prices much over the market rates for the indigenous kind. There is therefore every prospect, at least in the Poona district, of being now able to effect in the course of a few years a thorough change in the stocks cultivated, but it must be added that there is little prospect of inducing the *rayats* to give their land the needed rest from potato, without which all measures can only be palliative, and no permanent cure can be expected.

[The following Dictionary articles may be consulted in connection with the above subject:—

Fungoid Pests, *Vol. III.*, **F. 745.**
Oryza sativa, *Vol. V.*, **O. 436.**
Pests, *Vol. VI., Part I.*, **P. 432.**

Since the date of preparation of the above review of the Bombay Presidency experiments with the Indian potato disease, a most valuable "*Report on Recent Experiments in Checking Potato Disease in the United Kingdom and Abroad*" has been issued as a Parliamentary Paper by the Board of Agriculture. It may serve a useful purpose, therefore, to furnish here some of the chief features of that Report. In Part I. **Mr. Charles Whitehead** gives a most instructive historic and descriptive account of the disease. It first appeared in Europe in 1844, about the same time that an allied fungus **(Oidium Tuckeri)** attacked the vine. The potato disease was examined by **Dr. Montagne** in France and by **Mr. Berkeley** in England—two distinguished botanists who in 1846 laid the foundation of our knowledge of the subject by establishing

the disease to be of fungoid origin. In 1872 **Prof. A. de Bary,** the well-known German mycologist, in a paper which appeared in the Journal of the Royal Agricultural Society (*Vol. XII., 2nd Series*), gave it the name of **Phytophthora infestans,** while at the same time he reduced the old genus to which, by the earlier writers, it had been referred—*viz.*, **Peronospora**—to three genera: **Cystopus, Peronospora,** and **Phytophthora** (*l. c., p. 240*). But there was one point deficient in **Prof. de Bary's** life-history of the fungus—he had not found the resting-spores. This defect was shortly after corrected by **Mr. Worthington G. Smith,** who fortunately discovered these spores, and thus not only completed the life-history of the fungus, but showed thereby the manner in which the perpetuation of the pest was carried through the winter months. As a corollary of the discovery of resting-spores, the duty became imperative to remove from the field or to destroy all haulm, all refuse, all diseased tubers, and to avoid the cultivation of potatoes upon a resting-spore impregnated soil, for at least two or three years.

Resting-spores.

The report very properly points out that to know the life-history of the disease was half the battle. Both prevention and cure must be directed against each of the methods of reproduction or stages of growth. It may be of interest, therefore, to very briefly, and as far as possible in popular language, give here an account of the fungus.

It belongs to the family of **Peronosporeæ,** and hence, like all the other members of that family, is reproduced in either or both of two methods: (1) by the hibernation within the tubers of mycelia which on the germination of these tubers grow up in the interior of the stem and destroy the plant by using up, as it were, its life-substance; and (2) by resting-spores (*oospores*) that survive through the winter. These are like minute seeds, and they are found resting on the decayed portions of last year's crop, on rubbish of any sort, or even in the soil.

Methods of Reproduction.

Disinfectants useless.

A plant affected by a fungus of this nature would obviously not be benefited by having its seed or tubers washed by disinfectants, since the mycelia are in a state of hibernation *within the tissue of the seed or tuber* (as in the case of the potato) and not external.

Production of Resting-spores.

Having thus established the alternative methods of reproduction possessed by this destructive fungus, we may trace out its wonderful life-story by dealing first with the resting-spores. These minute *oospores* or seeds (if we may call them so) are only about one thousandth part of an inch in diameter, are nearly round in shape, and in colour from light to dark brown. They are produced by the action of the *antheridia* (or pollen) on the *oogonia* (or pistil) of the mycelium within the diseased potato-leaf. They are retained by the decaying haulm, leaves, tubers, etc., whether lying on the field or on the dung-heap. Under favourable circumstances these *oospores* germinate and produce *conidia*, which in their turn yield 8 to 10 *zoospores*. These

organisms, which may be called the ultimate reproductive bodies, are only about $\frac{1}{2500}$ part of an inch in size. They are, however, provided with two cilia (or vibrating arms), by which they are able to move about or swim in water. Wafted by the slightest breeze these *zoospores* in time are brought under favourable conditions of growth; they then produce the mycelium or vegetative system, the fungus. This is accomplished by *hyphæ* or root-like structures being elongated which penetrate the entire structure of the potato plant, and in doing so absorb the assimilated food which was destined for storage in the tuber. The growth of the mycelium thus causes the premature death of the stem, and finally the fungus takes up its abode, so to speak, in the tuber, where in many cases it lies dormant, only to renew its activity next year if diseased tubers be employed as seed-potatoes.

Ultimate Reproductive Bodies.

But there is still another method by which *zoospores* are produced, and this may be traced by describing the growth of the potato plant raised from diseased tubers. As already remarked, the hibernating mycelium or fungoid structure, on the sprouting of the potato, resumes its activity, and, growing up with the elongation of the potato stem, ultimately attacks the entire structure. On reaching the leaves it gives origin to *ærial hyphæ*, which, escaping through the respiration mouths (*stomata*) of *the under-surface of the leaf*, ultimately branch and produce on the extremities of their branches *condia*, which on bursting yield *zoospores*.

Production from Hibernating Mycelia.

Whether produced from the resting-spore or by the growth of the mycelium that had hibernated in the tuber, the *ærial hyphæ* when they appear form a woolly-like fringe on the margin of black decaying portions of the leaf. This fringe is known as mould or mildew. As it advances across the leaf it practically kills the tissues on which it has lived. But that is not all, for it is the while pouring destruction for miles around, through the discharge of countless *condia* cells—cells that are being carried by the wind, by animals, by insects, by a thousand and one agencies, until one mildewed leaf may destroy the entire potato crop of a district. Thus through the carelessness of one cultivator, in using diseased seed-tubers, the entire potato crop of a neighbourhood may be destroyed, just as in a like manner, through the indifference or selfishness of one cultivator, in leaving the weathered portions of a previous diseased crop on the field or in growing potatoes on a disease-infected soil, the crops of his neighbours may be entirely ruined.

External manifestations.

Having now traced out very briefly the chief features of the life-history of potato disease, it may be said that the second part of the very instructive report under review (published by the Board of Trade) deals with the experiments conducted in Europe to combat this terrible malady. The salient points brought out may briefly be said to be—

Treatment.

First.—The importance urged of the fact that the *ærial hyphæ* are produced on the *under-surface* of the leaves. In this respect

Bouillie Bordelaise Treatment.

the potato disease differs materially from the somewhat similar vine disease. It is more easy to wash the upper surface of the leaves of a plant than the under; hence the greater success of the *Bouillie Bordelaise* treatment of the vine than the potato. While not refusing to believe in the value of that treatment, the report would seem to contend that less success has attended the experiments in England than is claimed for it on the Continent of Europe.

Second.—The immense importance of checking the disease through contending against the reproduction by resting-spores.—Careful agriculture may be said to be the key to this. All decaying matter of last year's crop should be destroyed, and a second crop of potatoes never taken off an affected soil until after two, if not three, years.

Third.—The careful avoidance of diseased seed-potatoes.

Finally, it may be said the report shows that by the observance of the second and third recommendations, prevention might be looked for as more effective than the cure briefly alluded to under the first consideration.

In conclusion, it may be said the Bombay experiments appear to have been chiefly directed to the destruction of resting-spores from affected fields through flooding with water charged with sulphate of copper. The Editor would recommend a trial being given to the Panjab method of killing injurious organisms in flooded fields by the use of the common weed **Adhatoda Vasica** (*Vol. V.*, **O. 436**), provided the object be to disinfect fields suspected of harbouring resting-spores. The use of that insecticide seems to have been attended with very considerable success by tea planters who have tried it on the mosquito, and in the Editor's original experiments conducted in 1887 he found it most effectual in killing fungoid pests. But it may be remarked in conclusion that it has by no means been satisfactorily demonstrated that the Indian potato disease corresponds absolutely with the European, or rather that we may not have two or more such diseases. The caution with which this point is approached by Indian experts is at least significant.—G. W.]

G. I. C. P. O.—No. 1355 R. & A. D.—6-8-94.—A. McL.

S. 2330.

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SUGAR.

[*Dictionary of Economic Products, Vol. VI., Pt. II.*]

(*Classification of Sugars*) S. 367–377; (*Manufacture of Sugar*) S. 383—393; *etc. etc.*

KINDS OF SUGAR WHICH MAY BE CLASSED AS REFINED.

Note by MR. T. O. MILLER, *Director, Land Records and Agriculture, North-Western Provinces and Oudh.*

THE following note on the kinds of Indian sugar which may be classed as refined was supplied by Mr. T. O. Miller, Director of Land Records and Agriculture, North-Western Provinces and Oudh:—

Definition.

Strictly speaking, *refined sugar* only includes sugars which have been purified by charcoal strainers as well as freed from all admixture of uncrystallized syrup. But, if this meaning be adhered to, no sugars of Indian manufacture can be classed as refined, since the use of charcoal strainers is unknown. Indian sugars may therefore be classed as unrefined according as they do or do not fulfil one of the two conditions noted above,—*i.e.*, according as they have or have not been freed from admixture of uncrystallized syrup.

Gurh and Rab.

The immediate product of the first boiling of the cane juice may be either *gurh* or *rab*, according as the sugar is boiled down to a hard compost or allowed to remain in a semi-liquid condition. *Gurh* may or may not be clarified by the addition of lime, sulphate of soda, or carbonate of soda. If so clarified it is sometimes known as *shakar*, being of a lighter colour, better granulation, but less sweetness than unclarified *gurh*. *Rab* is but seldom clarified in this manner.

Both *gurh* and *rab* consist of uncrystallized syrup mixed with uncrystallized sugar, and are of course both unrefined.

Gurh, as a rule, is intended for consumption, and is comparatively seldom used in the manufacture of refined sugar. *Rab*, on the other hand, is solely intended for being refined.

Process of refining.

In the process of refining as practised in the Khansaris of Rohilkhand, the uncrystallized syrup (or *shira*) is first of all partially expressed from the *rab* (or occasionally *gurh*) by the primitive contrivance of a man standing on a pile of bags filled with *rab*, and working them backwards and forwards by the movement of his body. The *rab* which has been partially refined in this way is called *putri*, and, though it still contains a large percentage of *shira*, is far more compact, and shows more granulation than before the pressing.

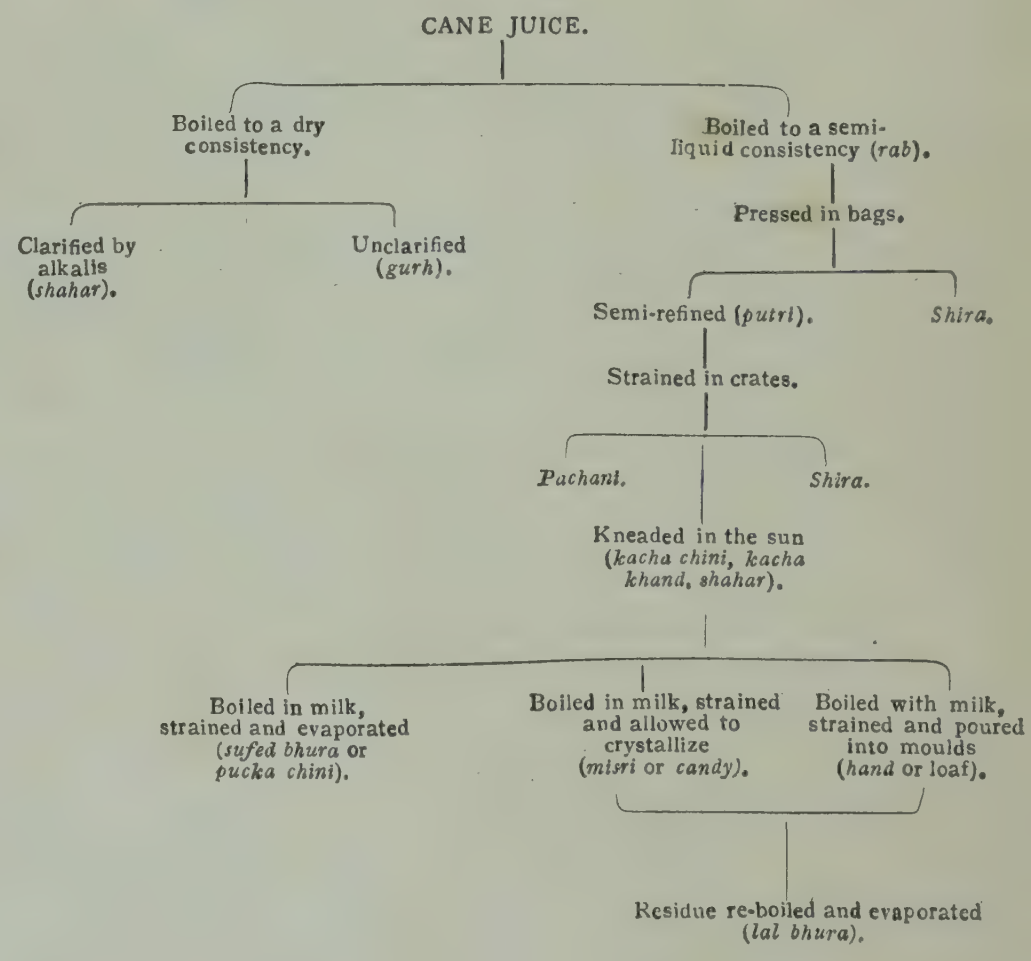
Process of refining.

The *putri* is thrown into a crate, covered with the water weed known as *siwar* (**Vallisneria spiralis**, *Dic., Vol. VI., Pt. IV., p. 220*) and left to stand. The remaining syrup slowly soaks down and out at the bottom of the crate, and the surface of the *putri* gradually whitens into a mealy-looking sugar which is called *pachani*, as it is scraped off every other day or so, and *kacha chini, kacha khand* or *shakar*, when it has been dried in the sun and kneaded by being trampled on for some hours.

This *kacha chini, kacha khand* or *shakar*, is the first product in sugar-refining, which may be called refined sugar. The work of the professional sugar refiner ends with it, and the still more refined forms of sugar, known as *sufed bhura* (the sugar ordinarily consumed by well-to-do natives), *misri* (or sugar-candy), and *khand* (or loaf-sugar), are all manufactured by the *halwais* from it.

Sufed bhura results from boiling *kacha chini* with milk, skimming and straining the liquid, and then evaporating it to dryness. In making *misri* this liquid is allowed to crystallize in earthen vessels, and in making *khand* it is poured into moulds. In both of these latter cases there is a residue of syrup, which, after being re-boiled and evaporated to dryness, is called *lal bhura*.

The following table will make the foregoing summary clear :—


CANE JUICE.
Boiled to a dry consistency.
Boiled to a semi-liquid consistency (*rab*).
Clarified by alkalis (*shahar*).
Unclarified (*gurh*).
Pressed in bags.
Semi-refined (*putri*).
Shira.
Strained in crates.
Pachani.
Shira.
Kneaded in the sun (*kacha chini, kacha khand, shahar*).
Boiled in milk, strained and evaporated (*sufed bhura* or *pucka chini*).
Boiled in milk, strained and allowed to crystallize (*misri* or *candy*).
Boiled with milk, strained and poured into moulds (*khand* or loaf).
Residue re-boiled and evaporated (*lal bhura*).

Classed as refined. | SUGAR.

[Throughout the entire chapter on the sugar manufactures of the various provinces of India (that will be found in the Dictionary of Economic Products) similar statements are given regarding the production of refined sugar. In every line greater care in the use of such terms as sugar, molasses, jaggery, raw sugar, refined sugar, sugar-candy, etc., has been urged. Indeed, much confusion and a deal of false information has been currently disseminated regarding the production and consumption of sugar in India through some of these terms being accepted as synonymous.—G. W.]

S. 367—377.

G. I. C. P. O.—No. 1357 R. &. A.—28-5-94.—1,500.

(Vegetable Product Series, No. 7.)

THE AGRICULTURAL LEDGER.

1893—No. 8.

SOLANUM TUBEROSUM, *Linn.*

[*Dictionary of Economic Products, Vol. VI., Part III.*, S. 2322–2338.]

HILL POTATOES USED AS SEED IN BENGAL.

Note by MR. B. C. BASU, *Assistant to the Department of Land Records and Agriculture, Bengal.*

Larger yield from Naini Tal seed.

THE following note is from a Report on "The Dumraon Farms: What they teach," by Mr. B. C. Basu, Assistant to the Department of Land Records and Agriculture, Bengal:—

Different varieties of potatoes have been compared at Bhojpore since 1887-88 with the local variety of potato. This latter is annually imported from Bettiah. It is found the hill variety generally yields a larger outturn than the local. In the first three years the hill variety which was tried was obtained from Darjeeling, but good seed not having been available in subsequent years, on account of the blight which had appeared in the Darjeeling crop, hill seed was subsequently imported from Naini Tal in the Kumaon district of the North-Western Provinces.

The results of the comparative trials were as follows:—

	OUTTURN PER ACRE.			
	Hill seed.	Local seed.	Increase.	Decrease.
	Mds. s.	Mds. s.	Mds. s.	Mds. s.
1887-88.				
Ex. 1	270 32	204 0	66 32	...
1888-89.				
Ex. 2	100 14	112 6	...	11 32
„ 3	63 18	116 29	...	53 11
„ 4	66 16	71 35	...	5 19
„ 5	57 34	59 1	...	1 7
1889-90				
Ex. 6	161 13	148 9	13 4	...
„ 7	136 5	128 22	7 23	...
„ 8	114 38	105 35	9 3	...
„ 9	113 17	90 30	22 27	...
1890-91.				
Ex. 10	121 36	96 32	25 4	

SOLANUM tuberosum. **Hill Potatoes used as seed in Bengal.**

Thus, out of four years, the hill seed gave a larger outturn than the local and less only in one year.

Superior quality.

There are many things to be said for and against the hill varieties of potato. They were English varieties in origin, but had been naturalised in the hills. They are very unlike the local variety. The latter is small in size, has yellowish and waxy flesh; the former, on the contrary, are much larger, with a white skin and beautifully white and mealy flesh. They are very much liked by Europeans, and sell much better than the local variety in Calcutta and other large towns. In 1887-88, Darjeeling potatoes grown at Bhojpore were valued in Calcutta at ₹2 per maund, against ₹1-8 for the local variety. In 1890-91, the potatoes grown from Naini Tal seed were sold to dealers at Dinapore and Buxar at ₹1-8 per maund, when the local variety was selling at 14 annas. In 1891-92, again, the former fetched ₹1-10 per maund, while the local variety realised only ₹1.

Experience has shown that seed potatoes do not keep well in the hot climate of South Bihar, and consequently every year fresh supplies have to be imported from elsewhere. This difficulty is common to both the local and the Naini Tal varieties; in the case of the latter, the cost of transport will no doubt be somewhat greater than in the case of the former. The hill seed used for experiment on the Bhojpore Farm was obtained from Calcutta; the cost was consequently very heavy, but if a demand for it exists in Bihar, it is just as easy, and certainly considerably cheaper, to get it direct from Naini Tal.

The difference in market value is of even more importance than the actual weight per acre.

[It will thus be seen that Mr. Basu has demonstrated once more the immense value to India of some definite system of interchange of seed. There are, of course, limitations to this principle, but these can alone be determined by careful experiment conducted until it is discovered what districts or regions afford the best seed of each crop for a given locality. It would, for example, be interesting to know what led indigo planters to go to the North-West Provinces for seed. Was this an accidental selection, or had the point been previously ascertained? Other papers on the interchange of seed would be most thankfully received by the Editor.]

S. 2322—38.

G. I. C. P. O.—No. 1359 R. & A.—28-7-94.—1,500.—A. McI..

(Vegetable Product Series, No. 8.)

THE

AGRICULTURAL LEDGER.

1893—No. 15.

ARACHIS HYPOGÆA.

[*Dictionary of Economic Products, Vol. I.*, A. 1261—70.]

THE GROUND-NUT OR EARTH-NUT:

A Review of recent information by THE EDITOR.

Imperial Institute Hand-book.

The present number of "The Agricultural Ledger" may be described as a revision of the Imperial Institute Hand-book No. 24, which was issued by **Mr. Edgar Thurston.** That Hand-book was itself, however, but a reprint of the article on **Arachis hypogæa,** as given in the Dictionary of Economic Products, Vol. I., A. 1261, with a few modifications and additions derived from notes furnished by **Mr. C. Benson,** Deputy Director of Agriculture, Madras, by **Mr. J. Mollison,** Superintendent of Farms, Bombay, and by **Dr. J. W. Leather,** Agricultural Chemist to the Government of India.

Sources of information.

It is hoped that this paper may, therefore, be found to bring certain features of the subject up to date, and that at the same time it may serve to exhibit the numerous deficiencies that still exist in our knowledge of the present position of the agricultural and commercial industries of growing the nut and expressing the oil therefrom. In its preparation the admirable article by **Mr. C. K. Subba Rao** (which appeared in the Madras Agricultural Bulletin) has been freely utilized; certain statistical information furnished by the French authorities at Pondicherry has been incorporated; and the Proceedings of the Revenue and Agricultural Department of the Government of India of some 15 to 20 years ago drawn upon for particulars regarding the subject—the period when public attention in India was for the first occasion forcibly directed to the desirability of this country more largely participating in the foreign trade in ground-nuts.

ARACHIS hypogæa. — A Review of recent information on

HISTORY.

Arachis hypogæa, *Linn., Fl. Br. Ind., II., 161 ; Leguminosæ.*

GROUND-NUT, EARTH-NUT, MONKEY-NUT OR PEA-NUT, *English*;

ARACHIDE, PISTACHE DE TERRE, *Fr.*; ERDNUSSÖL, *Germ.*

Vern.—*Mung-phali, vilayetí-mung,* HIND.; *Mát-kalaí, chiní-bádám, bilátí-mung,* BENG.; *Moha-bádám,* NEPAL; *Múngphali, wiláyati-mung, chíni-badam,* N.-W. P.; *Mung-phallí,* PB.; *Bhui-mung,* SIND; *Bhui-singh,* BOMB.; *Bhui-mug, bhui-chane,* MAR.; *Chíní-mung, bhui-chená,* GUZ.; *Ver-kadalai, nila-kadalai, kadalaikai, manilla-kottai,* TAM.; *Veru-sanagalu, manilla-ginjalu, néla-sanagalu,* TEL.; *Bhui-mug,* KAN.; *Myé-leh, mibé, myépe, maibai,* BURM; *Rata-kaju,* SING.; *Bhu-chanaka (earth gram,* SANS.). In Java the oil is said to be known as *Katjang,* a name which has occasionally found its way into commercial publications.

References.—*Index Kewensis I., 170; Benth., Fl. Brazil., Papil. p. 86; Roxb., Fl. Ind., Ed. C.B.C., 252; Oliver, Fl. Trop., Africa II., 158; Stewart, Pb. Pl., 57; DC. Orig. Cult. Pl., 411-113; Bretschneider, Study and Value of Chinese Botanical Works, 18; Mason, Burma and Its People, ed. by Theobald, Vol. II., 500; Rumphius, Amb., V., 426; R. Brown, Botany of Congo, 53; Bentham Flora of Brazil, XV. Pl., 23; also Trans. Linn. Soc., XVIII., 159; Pharm. Ind., 74, 446; Fluck. & Hanb., Pharmacog., II Ed., p. 186; U. S. Dispens., 15th Ed., 977; Murray, Pl. & Drugs, Sind., 122; Bent. & Trim. Med. Pl., 75; Dymock Mat. Med. W. Ind., 2nd Ed., 246; Dymock, Warden and Hooper, Pharmacog. Ind., Vol. I., 494; C. K. Subba Rao, in Madras Bulletin No. 28; Birdwood, Bomb. Prod., 217, 281; Drury, U. Pl. Ind., 46-8; James, Indian Industries, 366; Manual and Guide, Saidapet Farm, Madras, 54; Watt, Soap-making, 42; Church, Food-Grains, Ind., 127; J. E. O'Conor, Review, Trade and Nav. Ind., 1892-93, p. 28; 1893-94, p. 46; Simmonds, Tropical Agriculture, 404; Voelcker, Improvement of Indian Agriculture, 105 207, 347, 370; 417 (analyses of cake); Nicholson, Man. Coimbatore, 224, Man, Cuddapah Dist., 199; Bombay Administration Rept., 1872-73, 357; Bomb., Man. Rev. Accounts, p. 103; Gazetteer, Bombay, II., 277-280; XII., 152; XXI., 104; Jour. Agri.-Horti. Soc., Ind., VI. (N. S.), 87-88; Gardener's Chronicle, Sept. 4th, 1880; Smith's Dict. Econ. Pl., 161; Spons., Encycl., II., 1357 and 1391; Balfour, Cyclop. Ind., I., 1255.*

History.—According to most modern writers the ground-nut is a native of Brazil. It belongs to a genus that possesses six other species, all of which are indigenous to that country, and it is, therefore, probable that, although the ground-nut itself has not been reported as met with anywhere wild, that is possibly due to its being but a cultivated state derived from one or other of the wild species. It would be contrary to all experience in geographical botany to admit the possibility of a genus, the wild members of which are at the present day confined to one portion of the American Continent, having had at some remote period a further wild species which was diffused throughout both hemispheres but which is now become extinct except as a cultivated plant. Moreover, the most ancient authentic record, connected with this plant, may be said to be the discovery of the seed in the Peruvian tombs at Ancon.

Origin and habitat.

The authors of the Pharmacographia Indica, however, affirm that "the ground-nut is a native of Africa," but they produce no evidence in support of that opinion. In 1818 Robert Brown advanced the opinion that the ground-nut was very possibly in-

HISTORY.

troduced into India from China. He also held that it was not improbable that it was brought from Africa into different parts of equatorial America, and he advanced that opinion while freely admitting that it is mentioned in some of the earliest writings of Peru and Brazil. It may here be remarked that these writings are more ancient than the earliest mention of the nut in the literature of Asiatic and European plants. De Candolle says on this subject: "The antiquity and the generality of its cultivation in Africa is, however, an argument of some force, which compensates to a certain degree its antiquity in Brazil, and the presence of six other Arachis in the same country. I would admit its great value if the Arachis had been known to the ancient Egyptians and to the Arabs; but the silence of Greek, * Latin and Arab authors, and the absence of the species in Egypt in Forskal's time, lead me to think that its cultivation in Guinea, Senegal, and the East Coast of Africa is not of very ancient date."

It is, however, somewhat significant that its Brazilian and other American names should not have accompanied it in its distribution over the world. Marcgraf & Piso (*Brazil, p. 37, Ed. 1648*) give it the name *Mandubi*. Acosta gives it the American name of *Mani*. The Peruvian name for it appears to be *Anchic*. The Chinese name means simply "earth-bean,"—a designation that might naturally enough be given to the plant by the people of every country into which it chanced to be introduced. Sir George Birdwood, in his *Bombay Products*, gives it a Sanskrit name (which may be translated as earth-gram), and this has been repeated by many subsequent writers without the authenticity or antiquity of that name being enquired into. In consequence it has by some writers been assumed that the pea may have an antiquity in India of which we have no record. But, on the other hand, the whole of the modern vernacular names for the plant are, like the so-called Sanskrit, names that might readily enough have occurred to any one on seeing the plant. In a valuable paper by Mr. C. K. Subba Rao (published in *The Madras Agricultural Bulletin No. 28*) the following remarks occur: "One name for this product in South Arcot, where it is chiefly cultivated, is *Manillá kottai*. This name is generally believed to show that the plant was introduced from Manilla. It is, therefore, possible that the ground-nut found its way from the New World to India, *viá* the Philippines. Locally some persons explain the name *Manillá kottai* as a corruption of *Manali kottai*, which means the 'Sandy-soil-nut.' Another derivation has been suggested; that is, a corruption of '*Mannil-agum-kottai*' or 'nut borne under ground.' So again in South Arcot, Chingleput, Shiyali the plant is called *Verkudalai* or root-gram, signifying the nut resembling Bengal-gram borne under ground. In Coimbatore, Salem, and Tanjore it is known as *Nilak-kadalai* or ground-gram." "The Telugu names are mere transla-

* Sprengel's explanation of a passage in Theophrastus as alluding to this plant is not now admitted.

ARACHIS hypogæa. A Review of recent information on

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tions from the Tamil." It is significant that neither Sir Walter Elliott (*Flora Andhrica*) nor Ainslie (*Materia Indica*), two of the best writers on South Indian economic plants during the early decades of this century, should make mention of the ground-nut, nor of its Tamil and Telugu names. In the same way Udoy Chand Dutt (*Materia Medica of the Hindus*) does not allude to it, a fact that might be explained away by saying that the oil has only been used medicinally within the past few years. But that explanation necessitates the enquiry why so exceedingly valuable an oil should not have been in use for centuries, if the plant was known to the Sanskrit-speaking people. The vernacular names in use in the other provinces of India are like those of Madras derivative or contrastive, such as *bilati-mung* (=Foreign-*mung*) and *China-bádám* (=Chinese-*bádám*). There is no Indian name that implies an ancient knowledge of the plant, and hence no evidence that can be adduced in the literature of this country to in any way shake belief in the commonly accepted

Early notices.

opinion that the ground-nut is a native of Brazil. But it is probably the case that the plant was repeatedly introduced into India before its cultivation became firmly established. It may have come from China to Bengal; from Manilla to Madras; and from Africa to Western India. Dr. Buchanan-Hamilton (*Travels through Mysore, South Canara, and Malabar, published in 1800*) refers to it as cultivated in Mysore

1800.

along with turmeric. One of the earliest definite allusions to it as a recognized crop occurs in the Annual Land Revenue Report of South Arcot for the year 1850-51, where it is stated there were then four

1850.

thousand acres under the crop. At the present date there are 150,000 acres of that district normally devoted to it. The Proceedings of the Revenue and Agricultural Department for 1879 give

1879.

much useful information regarding the crop for the five years preceding, and the facts then made known may now be regarded as historic data with which the present position of the trade in these nuts can be usefully contrasted.

Description.—Mr. Jackson's *Commercial Botany of the Nineteenth Century* gives many interesting particulars of the plant, from which the following may be quoted :—

The **Arachis hypogæa** plant is a diffuse, herbaceous annual, with procumbent branches, whose stock rarely attains a height of one foot and seldom flowers, unknown in a wild state, but now much cultivated for the sake of its oily seeds in all tropical and sub-tropical countries. The introduction of the ground-nut as an oil seed into European trade dates from 1840, since which time the imports into England have increased enormously. There are no authentic records of the imports of ground-nut oil, but West Africa, India, and China supply by far the largest bulk.

The Ground-nut. (*G. Watt.*) | ARACHIS hypogæa.

DESCRIPTION.

Mr. Jackson illustrates his account of the plant by the following woodcut, which by permission may be here reproduced :—

GROUND-NUT.

[*From Jackson's Commercial Botany of the Nineteenth Century.*]

Some years ago now the Editor wrote of this plant that, after the flowers wither, the torus (which supports the ovary or pod) becoming elongated in the form of a thick rigid stalk, and curving downwards, by alternately bending upon itself from one side to another, forces the pod underground, and in this position the peas are ripened. In India this curious plant often attracts to itself a large number of red-ants, which, in gardens in Bengal, seem regularly to soften and pulverise the soil as if to facilitate the movement of the pod. It would be interesting to know whether this peculiarity has been observed in other parts of the world, and, if so, to discover whether the plant feeds these useful insects in return for their assistance. They do not seem to eat the nuts or peas. But since the above was written it would appear to have been ascertained that the attraction for red-ants in large numbers does not occur in the ground-nut producing districts of the Madras Presidency. The illustration will be seen, however, to manifest the remarkable habit the plant possesses of forcing its fruits under ground, and it may be added that it would be extremely interesting were some person to endeavour to solve the object of this somewhat eccentric procedure.

Ground-nut an attraction for red-ants.

The subject of the ground-nut may be dealt with in this review under the following sections in order to bring the information available, under certain definite paragraphs, in accordance with the system

ARACHIS hypogæa. — **A Review of recent information on**

DESCRIPTION.

generally pursued in the Dictionary of Economic Products: (*1st*)—Its value as an agricultural crop (CULTIVATION); (*2nd*) Its OIL and OIL-CAKE; (*3rd*) ADULTERATION of the oil; (*4th*) Its uses in the DYEING and tanning industries; (*5th*) The MEDICINAL value and uses of the oil; (*6th*) The importance of ground-nut as an article of human FOOD and fodder for cattle; (*7th*) The MINOR USES of the plant (manure, fuel, etc.); (*8th*) The CHEMISTRY of the ground-nut and of its oil and oil-cake; and (*9th*) The Indian and Foreign TRADE in the various products of the plant.

I.—CULTIVATION.

In most provinces of India the area under this crop is not returned separately from other pulses, so that a complete statement cannot be furnished. The information at the disposal of the writer supplies, however, useful particulars regarding two at least (and these, so far as this crop is concerned, the most important) of the provinces of India, *viz.*, Madras and Bombay. But before proceeding to deal with the recent returns it may serve a useful purpose to introduce the subject by giving the concluding paragraph from a Note written by **Mr. J. E. O'Conor**, C. I. E. (Proceedings of the Revenue and Agricultural Department), dated 16th June 1879 :—

Total acreage in 1879.

French Imports.

Indian exports, 1878-79.

"From the information furnished by the provincial authorities, it would seem that the total recorded area under cultivation with this plant in all India is about 112,000 acres, exclusively in the Madras and Bombay Presidencies, Berar and Mysore. In the Bombay Presidency, the area (70,350 acres) is more than double that of Madras (34,630 acres), although such exportation as there is from British India to foreign countries is confined to the latter Presidency. Elsewhere, the nut is cultivated for food or for conversion into oil, in both cases for local consumption. The plant likes a light sandy soil and a considerable amount of water, with a tolerably equable, sub-tropical temperature, and these requirements may be supplied in many parts of the littoral of the Bombay and Madras Presidencies, the Eastern districts of Bengal, and the Burman coast. The cultivation is very profitable and the demand, which is mostly in France, is large. In 1878 the imports into France amounted to 111,443,366 kilogrammes, valued at 30,239,602 francs. Of this quantity upwards of 103,000,000 kilogrammes were imported from the Western Coast of Africa, where the Negroes have found the cultivation an uncommonly profitable investment. Our exports of the seed from British India in the official year 1878-79 amounted to only 25,472 cwt. (1,294,402 kilogrammes) or little more than 1 per cent. of the imports into France. The question now is, whether India should be content to leave France to draw all her supplies of this valuable food-stuff and commercial product from Africa, or whether she should not enter actively into competition for, at any rate, a substantial portion of the trade. The cultivation is no novelty requiring the removal of prejudices and other obstacles for its introduction. The plant is well known and appreciated by the people, and in some places the cultivation is already not insignificant, and there is abundant room for development. Cultivators would assuredly respond without delay or difficulty to any call made upon them for an increased production, but they can hardly be expected to undertake any considerable risk by largely increasing the area under the plant without first having an assured de-

CULTIVATION: MADRAS.

mand for the produce. It is for merchants to make this demand, and I think their attention should be drawn to the subject, and that it should be suggested to them that they might with advantage enter into relations with importers of this oil-seed at Marseilles, in view to a considerable augmentation of the supplies from India."

Government action.

The subsequent events will be seen to have abundantly confirmed Mr. O'Conor's anticipations, and it may, therefore, be said that this is one of the many articles of India's foreign export trade, the creation of which is directly traceable to the action of Government. In a Resolution, dated 2nd November 1877, the Government of India directed the attention of all Local Governments and Administrations to the desirability of India extending her foreign trade in these nuts. As the first step in that direction reports were called for regarding the existing industry. The numerous replies received were subsequently embodied in a Resolution, dated 15th August 1879, and Mr. O'Conor's Note was also published From the date of the appearance of these publications may be traced the rapid development of the foreign and internal trade in both the nut and the oil of this plant.

(*a*) Madras.

Sources of information.

The following brief account of the cultivation of **Arachis** in South India has been compiled from Mr. C. K. Subba Rao's most valuable paper (Madras *Bulletin of Agriculture, No. 28*); from Mr. C. Benson's notes on the subject (*Imperial Institute Hand-book No. 24*); and from the District Manuals and other such publications.

Soils.

Soils.—The cultivation is very simple. The plant thrives best on red sandy loams, and on soils rich in lime. But it is reported that when raised on the red soil known as *pottai-mannu* the nuts are unsuited for seed purposes. Accordingly the cultivators, whose lands are of that nature, annually import their supplies of seed from more favoured districts.

Rotation.

Rotation of Crops.—It is believed that the crop thrives best on moderately elevated land, such as near the villages, which are well drained but do not suffer from insufficiency of water. So profitable, indeed, is ground-nut cultivation that it is carried on with the aid of certain manures on the most unpromising kinds of soil. Of this nature may be mentioned the stony ground near Cuddalore which during the past ten years or so has been made to produce abundant crops on land that formerly was regarded as so unproductive that it had interruptedly to be left fallow for long periods. In small holdings of good soil it is not infrequently the case that ground-nuts are raised year after year on the same plots of land. But in larger estates a two-year rotation is pursued. The plant in greatest favour as the alternate crop is the millet *varagu** (**Paspalum scrobiculatum**). Continuous cultivation is believed to diminish the proportion of

Loss of Oil

* *Kodo*, in other parts of India.

CULTIVATION: MADRAS.

oil in the seed. The rotation pursued is to a large extent, however, dependent on the season of sowing that experience has found best adapted to each locality. For example, the millet *kambu** (**Pennisetum typhoideum**) is harvested so early that the land lies fallow for too long a period, and yet so late that if ground-nuts are sown immediately after, that crop is apt to suffer from want of rain. If ground-nuts following *cholum*† (**Sorghum vulgare**), the crop is said to be predisposed to the attacks of the insect pest known as *vér-púchi*. The crop does well after indigo, but not *vice versâ*. On irrigated dry land ground-nuts succeed best if following *kambu* or *ragi* (**Eleusine coracana**).

Manure.

Manure.—The crop (like most other valuable crops) is reported to be a very exhausting one and for that reason is heavily manured. But experience with this, as in other parts of the world with leguminous crops generally, it is found that farm-yard manure is by no means specially desirable unless applied to the soil in preparation for the crop that precedes the nuts. The best manure appears to be the silt deposits from tanks, and so highly is this valued that the cultivators carry silt from great distances and even pay high prices for the privilege of removing it. In South Arcot the fields are so manured once in four years with from 50 to 100 cart-loads per acre. The silt from the Perumal tank (that most in use in South Arcot) has been found to contain about 22 per cent. of lime and nearly 70 per cent. of sand. Ashes are also reckoned as good manure for the crop, more especially for poor sandy soils. This is sometimes applied every year at the rate of 30 cart-loads an acre.

Sowing.

Preparation of Land and Seasons of Sowing.—There is no special system of ploughing pursued with this crop ; the number of ploughings depends on the nature of the soil, the crop that precedes and the period consequently admissible for preparation and the resources or disposition of the cultivator. On unirrigated land the crop is sown any time between the middle of June and the middle of August. On irrigated land from the middle of August to the middle of September. In Vriddhachalam taluq (*pottai* soil) the sowings may be made as early as the middle of May, but in Trivellore as late as the middle of October. About 25 per cent more seed is required for late sowings, as these do not grow so luxuriantly as the early.

In South Arcot the crop is sown, in most cases, mixed with *kambu*, the seed being dropped in shallow holes made during the first hoeing of the standing millet crop; in other words, about a month after sowing the *kambu*. But it is said the nuts sown in this manner are particularly liable to be picked up by jackals, and the fields accordingly have to be watched for a few nights unless the soil be brush-harrowed and watered. The nuts are sometimes sown in furrows made by the plough immediately after sowing *kambu*, *tenai* (**Setaria italica**) or gingelly, the seed being covered by the next furrow opened. In Tanjore, North Arcot, and Chingleput districts

* *Bájrá;* † *joár*, in other parts of India.

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the crop is, as a rule, sown by itself in furrows made by a plough, each being covered in by the succeeding furrow as in the case of mixed cultivation. If sown by itself 25 per cent. more seed is required than for a mixed crop.

Seed.

Seed.—As already remarked, experience has shown that certain soils do not produce good seed. A considerable amount of selection of seed is, therefore, observed and great care taken in preparing the seed. The grain is found to be easily injured, and the pods are, therefore, hand-shelled for seed purposes. It is also believed that the pods for this purpose should not be shelled for more than five days before the seed is sown. In some cases one-seeded pods are picked out in order to be reserved as seed from the idea of not injuring the grain. In other cases many-seeded pods are simply broken into portions and the contained seed left with its protecting portion of the pod. About 90lb of seed per acre will suffice for sowings made up to the middle of August, but later on about 112lb are required. The crop is sown thickly as the bulk of the pods are borne within a few inches around the central stem. This will be seen in the illustration above, where 5 or 6 pods are seen below ground and close by the stem. Shortly after germination a young shoot appears above ground. This (especially after rain) is very sweet, and accordingly is greedily picked up by crows and other pests, so that the crop often requires to be watched at this stage.

Weeding: Irrigation.

After Treatment.—The crop is generally hand-hoed twice, about 15 men per acre being required each time. The bullock-hoe is not used owing to the injury done by it to the crop. In normal seasons ground-nuts, sown under irrigation, are watered twice a week during the last two months. While being watered it is customary to weed the plots and in some cases the plants are lightly trodden under foot with the object of bringing them into better contact with the soil.

Varieties.

Varieties of the Plant met with under Cultivation.—Distinct varieties of the ground-nut are not supposed to exist, but certain cultivated states or local manifestations are believed to possess special properties. As already remarked, the crop raised on *pottai* soils is unfit for seed purposes. Plants from such seed, instead of being procumbent, tend to become erect. But the appearance of the seed varies greatly with age, and hence has come into existence the recognition of light and dark seeded so-called varieties. So much so is this the case that according to the season of being gathered the seeds off the same individual plant might be classed as different varieties.

Conf. with p. 17.

Pests.

Enemies and Pests.—There are three insect pests called, respectively, *vér púchi, kambli púchi, and mudu púchi.* The *vér púchi* has not as yet been finally determined, but may possibly be a moth (Noctues), one of the so-called cut-worms. The larvæ eat the tips of the roots, the plant then withers and dies. Immediately after destroying one plant the larvæ attack others, the destruction appearing to radiate, in patches, but the ravages are seldom extensive. Lands cropped for a long time with ground-nuts are particularly predisposed to the attacks of these insects; it is also held that imperfectly decomposed farm-yard manure encourages the pest.

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The *kambli púchi* has been identified by Mr. Cotes as a moth belonging to the genus **Aloa.** The caterpillars of this insect consume the leaves, but the damage is seldom very serious, as the plants recover. They advance across the crop with alarming avidity, but may be checked by trenches round the plot.

The *mudu-púchi* is the most destructive pest. This is an obscure moth belonging to a group of very minute insects. When the crop is first attacked the leaves curl up until their margins meet. Within this will be found a tiny dark-coloured caterpillar. The leaves so affected die and fall to the ground and the crop withers away unless a heavy shower of rain falls. This pest does not show itself in isolated patches as in the *ver púchi*, but over the entire crop, causing in many cases complete destruction.

Other Enemies.

Other insect pests have been recorded in various localities, but none of these have hitherto proved serious. Jackals, however, are very fond of the ground-nut and often cause much damage. Dogs, monkeys, rats (especially the white field rat), squirrels, and pigs likewise often do much injury.

Pests.

Several fungoid pests have also been observed, but these have not as yet been subjected to careful investigation. Of this nature very possibly are the diseases spoken of as *perandai-novu* and *agni rogam.* In the last-mentioned brown spots appear on the leaves, the affection extending till the whole leaf turns brown and the stems become dried up.

Reaping.

Harvest.—The crop matures about six months after sowing. In a normal season one set of pods ripens at about the fourth month, a second a month later, and a third at the sixth month. The pods that mature early have the seeds darker in colour and drier in texture. They are sometimes called "white-ant-nuts." In places where fodder is scarce, the ground-nut haulms are carefully gathered at night, so as to preserve the leaf. Elsewhere unirrigated land is ploughed once or twice, the haulms are reaped off, and if the soil be fairly loose it is stirred by what is called a *mamoti kalappai*,—that is, a native plough with its working part replaced by the blade of a *mamoti*. The average outturn of haulms per acre is two cart-loads, weighing about a ton. Stiffish soils are dug by hand with a *mamoti*. About 40 to 80 women per acre are employed for gathering the nuts; the women grub in the soil for the nuts, which they collect in baskets. The wages are paid by a share of the outturn, and the share varies inversely to the estimated quantity and the current value of the produce, being, as a rule, so adjusted that each woman gets about $1\frac{1}{4}$ or $1\frac{1}{2}$ anna's worth of the pods. On irrigated land, ploughing is an unnecessary measure in harvesting. The haulms are collected and the land is moistened, the soil is then dug up with *mamotis* or hand-hoes and the pods are gathered. In a few villages, however, the crop is harvested very expeditiously by ploughing, and after letting in plenty of water, puddling the land. The pods then float, and are easily swept into a corner of the field, where a man and a woman can gather as much as would otherwise require 50 or 60 women

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to pick in the same time. The average outturn of ground-nuts, unirrigated, is about 50 bushels per acre; if the land be irrigated, the yield is at least double that amount. If a square yard of soil is found to yield a Madras measure, the outturn is regarded as very good, as it would be 5,000 measures per acre. The outturn naturally varies according to the nature of the soil, water-supply, treatment: it may range from 700 to 5,000 Madras measures of pods per acre. The Madras measure weighs about 1lb and, as a rule, 3 measures of pods yield one measure of kernels, but if grown on inferior, unirrigated land the pods do not yield more than one-fourth of their bulk of kernels. Bangalore, Tanjore, and Nagari seeds are noted for their weight. A Pondichery (French) candy of 529lb of kernels is said to equal 190 to 210 Madras measures. If a drought occurs about the fourth or fifth month the produce is gathered at once, lest subsequent heavy rain should cause germination of the ripe seeds; in other words, rain about the harvest time is disastrous. Should this occur the ryots endeavour to save as much of the produce as possible by ploughing up the land at once and exposing the pods on the surface.

Yield.

Danger to Ripe Crops.

Cost of Production and Profit.—It has been pretty satisfactorily shown that this is distinctly a profitable crop notwithstanding the labour and expense of cultivation. Higher rents are paid for land under ground-nuts than for most other crops. The average cost of cultivation, reaping, etc., on an acre of unirrigated land has by Mr. C. K. Subba Rao been put at R21-4, and the profit on the sales at R18-12. With irrigated land (after paying R12 to R15 for water) the same writer puts the profit at R32. In many places the ryots are able to obtain advances from the ground-nut dealers for their standing crops, and on these they pay interest at the rate of 32 per cent. per annum—a circumstance that would still further confirm the opinion that the crop is distinctly remunerative. The produce is sold either in the form of pods or kernels: in the later case it is customary to add a certain percentage of water to the pods before shelling, with the view of increasing the weight of the seeds.

Cost: Profit.

Prices.—According to Mr. Subba Rao the price paid at the place of production is normally about 36 Madras measures for the nuts in pod or, say, R19 to R22 per French candy of 529lb for the kernels. The prices paid at the sea-boards exceed the local price by at least the cost of transport, but it varies from year to year considerably, and within any one year it is lowest about January and reaches its highest rate about June. A writer in the *Madras Times* says:—

Prices.

"At the commencement of the season, that is, at the end of January and commencement of February, there were about 800,000 sacks of ground-nuts available. Prices raged high, as high as R32-8 per French candy, and freights were low for this part of the world; 32*s* would have been readily accepted, and many parcels, indeed, were taken by Clan Line steamers that dropped down from Madras at freights as low as 20*s*. per ton. This state of affairs appears to have encouraged holders of ground-nuts to keep back in hopes of obtaining yet higher prices and yet lower freights. The results have been disastrous, as prices have now receded to R26-8, and there is a probability of a

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Loss in drying.

still further fall, while freights have gradually crept up from 23*s.* to 25*s.* to 27*s.* 6*d.*, and 28*s.* 9*d.*, and have even in some instances touched 30*s.* The result has been again a holding back of the produce, and there is still a considerable quantity of produce lying in Pondicherry waiting transport. This delay is by no means favourable to the ground-nut, as it suffers considerably from dryage. Nuts stored in January lose 15 to 20 per cent. of their weight by September, not only from dryage, but from the attacks of a weevil."

Area.

Area under the Crop.—In the official papers to which repeated reference has been made above, the Board of Revenue, Madras, reported in 1876-77 that there were in that Presidency in all about 34,630 acres devoted to this crop. "The nut is not generally consumed as an article of food, but the kernel is fried and eaten by the poor, especially by children, more as a luxury than as an article of ordinary diet. The oil is used for lamps, giving a bright light free from smell and smoke, and sometimes for cooking purposes." From the remarks that follow, it will be seen how greatly opinion has changed; but in this place it may suffice to furnish a table in illustration of the expansion of the area of cultivation:—

Area under Ground-nut in 1882-83 and for the years 1887-88 to 1893-94

Districts.	Area under Ground-nuts.							
	1882-83.	1887-88.	1888-89.	1889-90.	1890-91.	1891-92.	1892-93.	1893-94.
	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.	Acres.
Trichinopoly .	5,796	11,133	14,922	16,365	15,520	11,661	10,849	10,312
Tanjore .	8,649	20,154	26,045	31,557	34,376	30,170	30,224	33,286
South Arcot .	48,220	82,362	131,544	185,876	152,937	120,611	138,748	148,860
North Arcot .	1,249	17,113	24,672	25,893	32,300	22,918	24,098	31,314
Chingleput .	7,876	7,991	11,635	15,200	18,876	12,843	16,796	20,144
Other Districts	1,778	2,754	3,072	4,464	4,574	3,141	6,195	3,881
Total for Madras Presidency .	73,568	241,507	211,890	279,355	258,313	201,344	226,910	247,797

The Ground-nut. (*G. Watt.*) | **ARACHIS hypogæa.**

CULTIVATION: MADRAS. Area.

It will be observed that the most striking example of the expansion of district cultivation has taken place in South Arcot. This was fully anticipated by the Madras Board of Revenue in 1878, for, commenting on the area at that time devoted to the crop (25,000 acres), the Board remarked—

"The Government have done what they could in remitting the export duty on the article, and the only stimulus which the Board think is wanting is a trade demand, and this is illustrated by the comparatively large products of South Arcot and Tanjore. From the Resolution of the Government of India, it appears that the article is chiefly in demand for France, and consequently in the above two districts where there are French Settlements, the supply is rising to meet the demand. In South Arcot 29,763 cwts. of seed and 44,020 cwts. of oil were exported by land and sea."

Practically the whole of the nuts referred to went to Pondicherry and about half the oil to that port, the balance being exported by sea chiefly to London.

It may, in conclusion, be pointed out that, although there has been a great expansion of the area devoted to the crop in the Madras Presidency during the last sixteen years, the past five or six have manifested a turn in popular favour, since the area has practically remained stationary. The rail-borne trade between the Madras Presidency and her port towns* would seem also to indicate striking modifications to have taken place since the year 1888-89:—

Trade by rail between Madras Presidency and the Madras Ports.

Conf. with Pondicherry Import Trade, pp. 15, 33.

Year.	Exports from the Presidency to the Ports.	Imports by the Presidency from the Ports.
	Mds.	Mds.
1888-89	1,925,345	1,794
1889-90	1,755,075	5,205
1890-91	1,694,881	8,774
1891-92	1,268,883	32,185
1892-93	999,976	11,537
1893-94	935,852	11,765

These returns may possibly be the direct expression of the stationary nature of the agricultural interests in this crop. But they are very significant in the light of the greatly expanding importance of Bombay in the traffic in these nuts.

* Madras sea-ports of official statistics are those touched by the railways, *viz.*, Madras Town, Pondicherry, Negapatam, Tuticorin, and Calicut.

CULTIVATION: MYSORE.

The share of these rail-borne imports from the Madras Presidency taken by Pondicherry will be seen below (p. 15), but it may here be stated that Madras port draws its supplies almost entirely from Chingleput and North Arcot. There seems to have been a revival in the transactions with the Madras port, during the last year, otherwise it might be said that they had been declining during the past four years. Thus the following were the shares of the above rail-borne traffic drawn to Madras ports—in 1890-91, 514,610 mds.; 1891-92, 250,298 mds.; 1892-93, 96,804 mds.; and in 1893-94, 337,350 mds.

MYSORE AND COORG.

Sources of information.

The material at the writer's disposal regarding the present position of the ground-nut trade in these regions is very defective, but the following passages from the Proceedings of the Government of India for the year 1879 may be regarded as instructive and as naturally forming a good basis for comparison. They are republished here with that object:—

Districts where cultivated.

"Cultivation almost wholly limited to the Bangalore and Kolar districts of Nundydroog Division. In the Bangalore district the statistics for 1873-74 to 1877-78 show that the average area annually under cultivation with the nut was 3,540 acres, with an outturn of about 3,131 tons, of which about 1,149 tons were exported. Of the remainder, 1,085 tons were returned for consumption, and about 897 tons used for extraction of oil.

"In the Kolar district the area under cultivation annually is stated to be 1,054 acres, yielding 1,640 tons; the greater portion of this quantity, *viz.*, 1,190 tons, was consumed locally as food, and the remainder, 450 tons, used for extraction of oil. It does not appear that any portion of the product is exported, but the Chief Commissioner apprehends that the information supplied on this point is defective."

Sowing and reaping.

"The plant is ordinarily cultivated as an alternative crop on land watered by wells; it is put down during the first rains in April to June and harvested in January or February following. The leaves are used to enrich the soil for the cultivation of sugarcane and other crops, which are considered more productive."

Production.

The returns of the rail-borne traffic for 1892-93 may be accepted as affording some conception of the extent of the Mysore production of earth-nuts. The province exported in that year 17,855 mds. and imported 4,605 mds. It is thus an exporting province and its surplus went to Madras sea-ports (12,698 mds.), to Bombay port (342 mds.) and to Madras Presidency (4,803 mds.). The Madras ports of official returns are those touched by the railways, *viz.*, Madras Town, Pondicherry, Negapatam, Tuticorin and Calicut.

FRENCH SETTLEMENT OF PONDICHERRY.

PONDICHERRY.

The importance of Pondicherry and other ports of the French Settlement in the ground-nut trade will be seen from the information given below under the chapter on trade, pages 33-34. A very large proportion of these exports is drawn, however, to the French ports from British districts, so that as an agricultural product of the French possessions this is not so very important as might at first sight be supposed. The following information has been obligingly fur-

nished by the French authorities as to the area of the Settlement devoted to the crop in 1892-93 :— CULTIVATION: PONDICHERRY.

Districts.	Kany	= Acres.
		Area.
Bahour	2,482	3,282
Villenour	3,106	4,107
Oulgaret	2,350	3,107
Total . .	7,938	10,496

The reduction to acres has been made on the assumption that one "kany" or "kawny" is equal to 1·3223 acres. The yield of this acreage (as shown in the French returns) seems altogether insufficient, unless (as indeed may be probable) some error has been involved in expressing the French weights and measures to the English equivalents. The yield given for the above acreage by the French authorities is equal to 1·6 cwt. an acre, or a total 16,786 cwts. The exports from the French Settlement have hitherto averaged about, say, 1½ million cwts. of seed. There is nothing to show that so large an amount as the difference between that figure and the estimated production is drawn (coastwise and rail) to the French ports in India from British districts. But if the yield that has been found to prevail in British districts be applied to the French acreage, *viz.*, 25-30 cwts. of pods to the acre, the production would have been 314,880 cwts. of pods or, say, 250,000 cwts. of seed—a figure which would seem under, rather than over, the production of the French Settlement. *Conf. with p. 33.*

As in the case of Madras, so in that of Pondicherry, there has been a remarkable decline in the amount of earth-nuts carried by rail during the past four or five years. This may be shown in a tabular form :— Rail-borne trade.

Imports of Earth-nuts by Rail to Pondicherry from the undermentioned British Districts.

Districts or ports whence obtained.	Imported into Pondicherry during			
	1890-91.	1891-92.	1892-93.	1893-94.
	Mds.	Mds.	Mds.	Mds.
Madras Port . . .	64	3,219	7,861	1,122
Negapatam Port . .	...	2,074	...	...
Chingleput and North Arcot	48,231	154,078	274,160	105,278
South Arcot, Tanjore and Trichinopoly.	982,077	837,664	608,564	473,660
Salem, Coimbatore, and Malabar.	5,904	4,788	958	4,628
Total .	1,036,276	1,001,823	891,543	584,688

Conf. with pp. 13, 33.

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It would thus appear that the imports into Pondicherry have been reduced by one-half within the past four years.

(*b*) Bombay.

Area.

In the early official papers (1877-79) at the writer's disposal the Bombay Government of that date reported that the nut was very generally grown in the Presidency, but almost entirely for local consumption. That should any great demand for the crop arise, an immediate and large extension of the cultivation would undoubtedly result. As already stated, the estimated total acreage was then 70,350, since which date the area under the crop has been doubled. A large export trade from Bombay in the nuts has also been organized; in fact in this respect the port of Bombay is very nearly three times as important as that of Madras.

The relative distribution of the crop in the various districts of the Presidency has not, however, been materially disarranged.

With the exception of the districts of the Deccan, ground-nuts may be said to be unknown to the cultivators of the Bombay Presidency. It is perhaps unnecessary, therefore, to deal with the subject in such detail as in the case of Madras—a province in which it is distinctly an important field crop. It may suffice to exemplify the departures in the systems of cultivation, yield, etc., from Madras experience and results to republish Mr. Mollison's Note on this subject as given in Mr. Thurston's *Imperial Institute Hand-book*:—

Mr. Mollison's report.

"A field of ground-nut has much the same appearance as a field of clover. A good crop forms a wealth of matted, trailing stems, which completely shade the ground and smother all weeds. The advantage thus gained, together with the ameliorating benefit which the soil receives by the growth of this and some other leguminous crops, makes ground-nut a favourite in the rotations practised on garden land.

Rotation.

Rotation.—Generally speaking, the cultivation of ground-nut is undertaken by well-to-do cultivators, and is an indication of prosperity and easy circumstances. It is often rotated with sugar-cane and chillies, and is occasionally taken where potatoes, onions, and brinjals (**Solanum Melongena**) are grown. In the garden land of Surat, where *chiclo* (a sedge) is a troublesome weed the growth of ground-nut helps to suppress it, and the thorough digging which the soil gets in removing the nut is very beneficial. Among garden crops ground-nut occupies the important position which gram holds among dry crops.

Soil.

Soil.—Although often grown on black land, it does better on light land, and delights in a good loam, unlike some of the commonly-grown pulses. A heavy crop cannot be got without liberal manuring and careful tillage.

Manure.

Manure.—Sheep or goat manure, applied either by folding the flock on the field or otherwise, is considered specially suitable, but, failing this, ordinary farm-yard manure should be applied in considerable quantity. Deep ploughing and thorough pulverisation of the soil before sowing help the crop materially

Method, season, etc.

Method of Cultivation: Seasons, etc.,—Ground-nut is usually a kharif (rain) crop, sown as soon as the previously prepared soil has been sufficiently moistened by the first fall of rain in June; but in the Deccan it is also grown as a rabi (winter) irrigated crop. The monsoon crop occupies the soil six to seven months, and in the absence of rain the land

must be kept moist artificially. It is usual to give two to four waterings during the last two or three months. The seed is usually sown between monsoon showers, when the land is dry enough to be worked by a plough. The husked seeds are dropped 2 or 3 inches apart by hand in the furrow made by an ordinary two-bullock plough, and are covered by the soil moved in making the next furrow. Three women sowing can keep pace with one plough. Forty-eight pounds of husked nuts will sow an acre. If the ploughing is carefully done, the rows are about 9 inches distant from each other, and are straight enough to be bullock-hoed. Another method of sowing is to use a four-coultered drill. The coulters form furrows, into which the seed is dropped by hand. A harrow is used to cover the seed. Behind the plough the wooden head-piece of the harrow, with the blade and prongs removed, is used. The crop should be weeded at least twice. As soon as it shades the ground, no further attention, except watering, is required.

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Sowing.

Harvest.—The crop is harvested like potatoes, sometimes with a plough, but more often the field is dug over by hand with a native pick. A cultivator collects a regular army of workers, and usually pays in kind. In order to expedite the digging, the haulms or vines are previously reaped and removed. These form an esteemed fodder.

Reaping.

Yield.—A good crop on suitable land, liberally managed, will yield up to 4,800lb of unhusked nuts per acre. An average crop will be about 3,200 to 3,500lb per acre. These figures only apply to good land. The proportion by weight of unhusked nuts to those with husk removed is as 4 : 3. This is the ratio after the nuts have been exposed two or three days, and are sufficiently dry for storage. They are usually sold unhusked, and are worth from 30 to 45lb per rupee, according to locality and season.

Yield.

The nuts are often dug for home consumption before the crop is dead-ripe, and are either eaten raw or parched.

Proportion of Oil.—Half the weight of the husked nut consists of oil."

Oil.

Prices.—According to the *Pharmacographia Indica*,—"In the Bombay market the price of the seeds ranges from R25 to R30 per kandy (5 cwts.) according as the supply is abundant or otherwise."

Price.

Varieties.—The Pharmacographia Indica also informs us that there are two forms—a light-coloured seed which is preferred for eating but does not yield much oil, and a reddish seed which yields much oil. Without assuming the existence of fixed and structural variations (from what has been said in connection with the South Indian ground-nuts) it may be affirmed that the light and dark-coloured conditions could easily be accounted for as due to the nature of the soil or even the age of the seed There is no evidence of the existence in India of botanical varieties of the species or even of racial forms.

Varieties.

Conf. with p. 9.

In the Nasik Gazetteer a brief account of this crop occurs, which may be here quoted in amplification of the above and as illustrating local practice:—

"It is a hardy and certain crop and pays well, the cost of tillage being small. After the land has been ploughed and smoothed, furrows are made close together, and the seed is dropped into them by the hand at intervals of about an inch, and covered with earth by means of a harrow. This is done soon after the rains set in, and the nuts want no watering till the rains are over. Afterwards they are watered every fifteenth day until December, when they begin to droop and are ready for digging. They

Cultivation Nasik.

CULTIVATION: BOMBAY.

should be several times weeded but want no manure. Women and children dig out the nuts. This is easy and popular work, since while digging they can eat as much as they like, besides getting a good supply of nuts as wages. Bhils are often seen wandering in gangs in search of jobs of this sort, armed with the heavy crowbars that are used in turning up the tangled roots."

Area.

Area under the Crop —The following statement of ground-nut cultivation in Western India has been supplied by the Director of Land Records and Agriculture, Bombay. By leaving the spaces blank against the names of certain districts, the purpose is served of forcing recognition of the somewhat restricted distribution of the crop. It will, for example, be seen to be unknown as a field crop in the Konkan, Gujarat and Sind :—

Statement of acreage under Ground-nut in the Bombay Presidency and Sind for the years 1892-93 and 1893-94.

Districts.	Area in Acres.	
	1892-93.	1893-94.
(A) Presidency Proper.		
I.—Gujarat.		
1. Ahmedabad	*Nil.*	*Nil.*
2. Kaira	...	...
3. Panch Mahal	...	...
4. Broach	...	...
5. Surat	295	240
II.—Deccan.		
6. Khandesh	4,696	6,278
7. Nasik	15,512	20,040
8. Ahmadnagar	3,991	6,498
9. Poona	16,248	18,785
10. Sholapur	36,788	45,371
11. Sátára	52,433	71,348
III.—Karnatak.		
12. Belgaum	12,417	15,973
13. Bijapur	79	89
14. Dhárwar	*Nil.*	*Nil.*
IV.—Konkan.		
15. Thána	...	...
16. Kolaba	...	...
17. Ratnágiri	...	...
18. Kánara	...	...
Total Carried over	142,459	184,622

The Ground-nut. (*G. Watt.*)

ARACHIS hypogæa.

CULTIVATION: BOMBAY.

Area.

Statement of acreage under Ground-nut in the Bombay Presidency and Sind for the years 1892-93 and 1893-94—continued.

Districts.	Area in Acres.	
	1892-93.	1893-94.
Brought forward .	142,459	184,620
(*B*) *Sind.*		
19. Karachi	*Nil.*	*Nil.*
20. Hydarabad	...	...
21. Shikarpur	...	...
22. Upper Sind Frontier	...	...
23. Thar and Párkar	...	...
Total . .	*Nil.*	*Nil.*
GRAND TOTAL . .	142,459	184,620

It will thus be seen that in several districts of this Presidency the cultivation of ground-nut is rapidly gaining in popular favour. In Sátára it may already be characterised as a crop of very considerable importance. There would thus seem no doubt that if the demand continues to improve, the production will be capable of direct response. The papers which the writer has consulted show that the districts that continue to manifest the greatest expansion are those which from the very first had taken the lead in this matter. This may be illustrated by the following summary :—

Districts.	Area in Acres.		
	1876-77.	1892-93.	1893-94.
Nasik	2,000	15,512	20,040
Poona	21,000	16,248	18,785
Sholapur	15,000	36,788	45,371
Sátára	29,000	52,433	71,348

It is probable the earlier returns were not so accurate as those of the present time, but assuming that they were relatively correct, the production in Poona (though again manifesting an improvement) has gone back from the figure given in 1876-77. The other districts have immensely improved. And this improvement has its direct expression in the fact that Bombay, and not Madras, is now the chief port in the ground-nut trade. As in the case of Madras, the rail-

CULTIVATION: BOMBAY.

Railborne-trade.

borne trade between Bombay Presidency and its port town may be here exhibited :—

Trade by rail between Bombay Presidency and Bombay Port.

Year.	Exports from the Presidency to the Port.	Imports by the Presidency from the Port.
	Mds.	Mds.
1888-89	446,160	3,724
1889-90	637,082	2,518
1890-91	915,803	2,293
1891-92	932,942	1,545
1892-93	1,233,866	1,791
1893-94	1,498,678	2,022

But in addition to the above supplies furnished to the port town Bombay Presidency exported in 1892-93 5,575 maunds to the other Provinces of India (thus Berar 3,499 maunds, Central Provinces 1,050 maunds, North-Western Provinces 406 maunds, and Madras 618 maunds), and 453 maunds to the Native States. The total exports from the Presidency by rail in 1892-93 came, therefore, to 1,239,894 maunds, and that amount plus local consumption and the amounts carried coastwise (see p. 38) must therefore have been the produce of the 142,459 acres which in that year were under the crop.

(*c*) Other Provinces.

With the exception of the progress made in Southern and Western India it may be said that there is little more to tell of the other provinces than was made public by the Government of India in their Resolution of 1879. In India generally the ground-nut is met with chiefly as a garden crop. And the movements of stocks as given in the Rail-borne Trade Returns denote the chief centres of supply and demand. The information available may be here briefly reviewed :—

N.-W. PROVINCES.

North-Western Provinces and Oudh.—As indicative of the unimportance of the crop in these provinces, it may be here mentioned that it is not dealt with in Messrs. Duthie and Fuller's *Field and Garden Crops*. Atkinson (*Food Grains of the North-Western Provinces*) says it is "cultivated in all parts of the plains for its pods, which bury themselves in the earth and there ripen their seeds. The plant flowers in June." The Director of Agriculture reported in 1879 that "it is cultivated as a garden, not a field, crop. The only districts in which it is known to have been grown are Banda, Hamirpur, Jaunpur and Mirzapur; it is sown in the months of June and July, and the crop is cut from December to February, the outturn being $4\frac{1}{2}$ to 15 maunds per acre. It is chiefly used for food, though in Banda and Mirzapur oil is said to be extracted from the seed. It is occasionally imported into the North-Western Provinces from Gwalior and Jubbulpur." In the year ending 31st March 1893 these provinces imported by rail 4,698 maunds of earth-nuts, that amount having been obtained from Rajputana and Central India (2,640 maunds), from

CULTIVATION: N.-W. PROVINCES.

the Central Provinces (1,603 maunds), and from Bombay (406 maunds). The Provinces exported by rail 278 maunds, which quantity was sent mainly to the Panjab. These figures, therefore, denote the entire trade, except the garden produce, consumed locally.

PANJAB.

Panjab.—Neither Baden-Powell nor Stewart deal with this crop—a circumstance that may be taken as showing its insignificance in the province. In the official papers it is said to be unknown as an article of local cultivation. It is, however, reported to be imported into Delhi from Bombay and Gwalior and to be generally sold throughout the province by the vendors of dried fruits. The manufacture of oil from the seeds according to a special report by the Financial Commissioner is unknown in the Panjab. The imports by the Panjab, drawn from other provinces by rail, amounted, in 1892-93 to only 1,133 maunds, which quantity came mainly from Rajputana and Central India (894 maunds) and from the North-Western Provinces (203 maunds). The exports were only 22 maunds.

CENTRAL PROVINCES.

Central Provinces.—In the earlier papers it is stated that it is generally believed land suitable for its production could easily be obtained, but that the demand must rise considerably before it would be possible to extend cultivation to any appreciable degree. There are no recent papers that manifest any material progression. It is fairly abundant as a garden crop, more especially in Jubbulpur and Nimar: indeed in the latter district it may be said to have become a recognized and regular crop. So far as denoted by the rail-borne traffic, the crop is, however, one of no great importance in these provinces. In 1892-93 the exports were 2,412 maunds, the bulk of which went to the North-Western Provinces (1,603 maunds) with smaller quantities to Central India (243 maunds) and to Bombay Port (409 maunds). Indeed these exports were more than counterbalanced by the imports—2,534 maunds—drawn from Bombay Presidency (1,050 maunds), and from Central India and Rajputana (1,188 maunds).

BERAR and CENTRAL INDIA.

Berar and Central India.—Although these regions are occasionally spoken of as exporting the nuts, particulars of production are not forthcoming. In the returns of 1879 regarding the Berars it is stated that there were 1,300 acres in Amraoti, 1,111 acres in Buldana, 259 acres in Wun, and 190 acres in Akola under the plant, but entirely as a garden crop. The rail-borne traffic for 1892-93 denotes an export from Rajputana and Central India of 10,402 maunds and an import of 518 maunds. From this fact it may fairly be inferred that there is a considerable production. One-half the exports go to Bombay port, and the other is distributed, as indicated above, to the North-Western Provinces, the Panjab and the Central Provinces. Berar, on the other hand, is shown in that year to have imported far more than it exported, *viz.*, 3,644 maunds imports and 276 maunds exports; it does, therefore, produce enough for its own demand.

BENGAL.

Bengal.—As in the upper provinces of India, so in the lower this crop is met with almost exclusively in the gardens of the rich. The imports of the seed are known, however, to be extending, and the

CULTIVATION: BENGAL. *Conf. with p. 25.*

production of the oil in its pure state or in mixtures with mustard and gingelly oils is rapidly becoming an important industry in Calcutta. It is therefore only natural to suppose that these facts may have encouraged a more extended local production in the districts than we possess any knowledge of. In the early returns earth-nuts are spoken of as a curiosity, and the rail-borne traffic of 1892-93 denotes very little interchange as taking place. The exports from Calcutta to the province came to 116 maunds, and there were no exports from the province.

ASSAM AND BURMA.

Assam and Burma.—There is practically no cultivation of the plant in these provinces. The Shans have been known to have produced a little, but the expansion of the cultivation has been in no way commensurate with the increased imports of Burma by sea, of both the nuts and oil. There is no traffic to or from Assam in earth-nuts.

OIL AND OIL-CAKE.

II.—OIL AND OIL CAKE.

THE OIL—The Government of India in its Resolution of 1879 published a brief notice of this oil which may be here republished as a fitting introduction to a review of the subsequent advances both in our knowledge of the substance and its utilization :—

Use of the oil.

"From the seed of the nut a considerable proportion of excellent oil is expressed, varying in quantity, according to circumstances, from 33 to 50 per cent. of the weight of the husked seed : the oil is of a light-greenish colour, very clear and bright, and is largely used in Europe and in India for illumination. It is also employed both for the table, when mixed with olive-oil and for the lubrication of machinery. The oil is in fact good for every purpose for which olive and almond oils are used ; it makes good soap, has the advantage of not quickly becoming rancid and of burning without smoke."

Properties of the oil.

Properties of the Oil.—The oil may be obtained by cold expression or by moderately heating the seeds before submitting them to pressure. The former process affords the best oil, but in smaller quantity than the latter. The cold-pressed oil is almost colourless, has an agreeably faint odour and a taste not unlike that of olive oil. That obtained by the hot process is dark-yellow coloured, and has a more or less disagreeable taste and smell. Although the oil does not turn rancid so quickly as with most Indian oils, by exposure it changes slowly, thickens and then becomes rancid. It is a non-drying oil, the best qualities of which have a sp. gr. of about 0·918 at 15°C. when fresh and 0·920 when old. It becomes turbid at 3°C., concretes at —3°C. and hardens at —7°C. As an illuminating oil it is now recognized as having but a feeble power, and its chief use is therefore in soap-making and as a lubricant. It is also much employed by perfumers in the preparation of pomades, cold creams, etc. The finer qualities are, however, used both in medicine and as an article of food, and there can be little doubt large quantities are annually passed off as olive oil. The seat of this oil industry may be said to be at Marseilles, though it is also produced at London,

OIL AND OIL-CAKE.

Hamburg, Berlin and other places. In *Spons' Encyclopædia* the following particulars occur as to the method of separating the oil :—

European Industry.

European Industry --"In Java, the oil is extracted by drying the seeds in the sun, and then subjecting them to pressure. In European mills the nuts are first cleaned, then decorticated and winnowed, by which the kernels are left perfectly clean. These are crushed like any other oil-seed, and put into bags, which are introduced into cold presses; the expressed oil is refined by passing through filter bags. The residual cake is ground very fine, and pressed under 3 tons to the inch, in the presence of steam-heat; this affords a second quantity of oil, inferior in quality to the cold-pressed. The usual product is 1 gallon of oil from 1 bushel of nuts by the cold process, besides the extra yield by the hot-pressing. In France, where the oil is most largely prepared, three expressions are adopted, as with some sorts of gingelly: the first gives about 18 per cent. of superfine oil, fit for alimentary purposes; the second, after moistening with cold water, affords 6 per cent. of a fine oil, suitable for lighting and for woollen dressing; the third, after treating with hot water, yields 6 per cent. of *rabat*, or oil applicable only to soap-making."

Indian Industry.

Indian Industry.—Throughout India the oil may be said to be expressed here and there for local purposes, but in South India it has assumed the proportion of one of the well-established and important modern industries. It will therefore be convenient to reproduce in this place the chief passages in Mr. C. K. Subba Rao's paper that deal with the Madras industry :—

South India.

South India.—"It is generally assumed that 190 to 210 Madras measures of seed equal a French candy (529lb), and 16 bags are taken as equal to five such candies, but the more oily the seed, the lighter it will be. Seed, the produce of red sandy loams and from soils freshly taken up for ground-nut cultivation, contains a comparatively large proportion of oil, and that produced on village sites or from stiff soils is comparatively poor in oil. The older the seed is the less oily it is. Fresh seed gives 114 to 120 tolas, and old seed 102 to 108 tolas of oil from three Madras measures of kernels. Seed produced on unirrigated land is more oily than that produced on irrigated land, 600 measures of the former or 650 measures of the latter yield 1 French candy or 529lb of oil. The seed produced in Tanjore and Shiyali is richest in oil. Nagari and Tirutani come next."

Oil mill.

"Oil mills of European patterns have been tried both at Pondicherry and Cuddalore, but they could not compete successfully with the native mills. The oil expressed in the first pressing by the European mills was good; but that obtained by the second pressing was dark and consequently rejected in the European markets. The cake being dry, wanting in oil, and powdery, was also everywhere rejected. So economically are the oil mills worked in Marseilles that ground-nut oil is cheaper in France than it is in South Arcot, the price being in Marseilles 45 francs per 100 kilos. last January, that is ₹70 per French candy, whereas in Pondicherry it was ₹80 per French candy.

"The oil is expressed locally in Native mills of the ordinary rotary pestle-and-mortar pattern. The chief centres of this trade are Valavapur (700 mills), Panruti (200 mills) and Pondicherry (200 mills). A single charge for a mill is from 15 to 18 Madras measures of seed, which must first be thoroughly dried. During the pressing water is added to the seed in small quantities. If the seed be well dried as much as 0·75 Madras measure, and if not well dried about 0·375 Madras measure of water

OIL AND OIL-CAKE.

South Indian Oil mills.

will suffice. After working for about half an hour, oil begins to collect and the kernels to cake. The cake is then loosened with a crowbar and about ¼lb of old ground-nut dust is mixed with the mass and work is then resumed. In 45 minutes after the commencement of the work about 3 measures of oil are ladled out of the mill. The cake is again loosened from the sides of the mill and the crushing continued. About five minutes afterwards a strip of cloth is dipped in the mill and the oil absorbed is squeezed out into a pot. In this manner about a measure of oil is taken out. Thereafter the oil is taken up on a brush or a bunch of fowl's feathers and the oil is squeezed out into the pot. The cake is then again loosened and broken up. About an hour after commencing the work, the oil collected in the lower cavity is removed by a strip of cloth fastened to an iron rod about 2 feet long which is dipped into it. In this manner another measure of oil is removed. Then another handful of ground-nut cake dust is added to prevent the adhesion of the cake to the pestle. After about one hour and a quarter, a torch at the end of an iron rod is lit and moved slowly all round close to the cake while the mill is working. For about 10 to 15 minutes the cake is thus heated, the object being to increase the outturn of oil. In an hour and half the work is over and the cake is dug out and put by. The last of the oil (about ¾ measure) is taken out." "In North Arcot and Chingleput districts the use of the torch in connection with the work of the oil-mill is unknown. The outturn of oil is about 25 per cent. by measure or 33 to 37 per cent. by weight of the kernels crushed. The oil-mongers are paid for crushing the seed R7 or R8 per candy of oil delivered to the merchants."

The above account may be accepted as thoroughly accurate. It is therefore extremely valuable as denoting the system followed in South India. Few persons are likely, however, to read the account of so cumbersome a process without feeling that want of enterprise alone must explain the admitted fact that the oil can be sold in Europe at a lower price than in the countries where the nuts are produced. There is, therefore, considerable interest in the following passages which have been taken from the *Imperial Institute Hand-book*:—

From 1890 to 1892 a steam oil-mill is said to have been at work in Pondicherry. It was, however, given up, as the cost of working was prohibitive as compared with that of the native oil-mill. The oil obtained by the first pressing by the steam-mill was good; but that obtained by the second crushing was discoloured, and rejected in the European market. Last year some wealthy Parsis from Bombay are reported to have visited Pondicherry, but to have come away discouraged as to the project of opening an oil factory. In the *Indian Engineer*, May, 1892, however, it was announced that "Pondicherry will shortly be able to boast the possession of an extensive factory for crushing ground-nuts and cocoa-nuts, and gingelly and other seeds, by steam machinery of the latest and most approved patterns, with a view to compete with the Marseilles oil manufacturers. It is claimed that the manufactured oils can be delivered in Europe at a much less cost than they can be produced from the crude materials; but the success of the scheme will not depend upon a foreign export trade. It is estimated that the quantity of oil at present manufactured in the colony and South Arcot approximates to 30,000 candies per year, which quantity, it may reasonably be expected, will increase as the quality of the oil improves. The projectors are wealthy Parsis of Bombay, and there should be no financial difficulties to block the way. The capital proposed to be employed is stated at from 3½ to 5 lakhs of rupees, which, it is

calculated, would ensure an average production of between 750 and 1,250 candies per day. The prospects of such an undertaking as that now proposed are undoubtedly good, and, if the business is properly and economically managed, and a sufficient working capital provided, the venture should pay" (*Imperial Institute Hand-book*).

OIL AND OIL-CAKE.

Bengal.

Bengal.—Although ground-nuts are not grown to any appreciable extent in Bengal it is somewhat significant that there should exist in Calcutta a mill owned by a European firm which consists of 10 steam (hydraulic) presses where pure ground-nut oil is expressed, according to the most improved method. The following brief note has been obligingly furnished by the owners of that mill:—

"The import of ground-nuts into Calcutta varies very much according as the seed is dearer or cheaper proportionately to other oil yielders. The Calcutta consumption of the pure oil is about 10,000 maunds per annum. It is used largely in making sweetmeats in place of ghí and is also mixed with ghí. If other oils are dear it is bought to mix with them, for it readily lends itself to this, having very little odour. In an ordinary year probably quite as much seed as used for the pure oil is ground up with rape seed, copra and *til* (sesamum) and treated thus it is next to impossible to detect the adulteration, the oil absorbing the flavour of the cake. The nuts vary greatly in the amount of oil they give according as they are green or well matured, and different soils seem more favourable than others for oil-producing seed. Pondicherry ordinary seed contains about 38 per cent. to 40 per cent. of oil and Madras about 6 per cent. more. The cake, if well pressed, retains about 8 per cent. to 10 per cent. of oil when pressed pure."

Conf. with p. 36.

As indicated in the above communication, besides a steam oil-press of the most improved fashion there are in Calcutta numerous Native presses that employ ground-nut in combination with mustard, cocoa-nut, gingelly and other oil-seeds in the preparation of mixed oils, which are very extensively employed for culinary and other purposes in Bengal. The extent of this Bengal trade may be directly judged of by the decline of the Madras exports of oil to Calcutta and the growth instead of coast-wise imports of nuts.

Oil-cake.

Oil-Cake.—The cake is highly valued in India both as an article of cattle food and as a manure. The cake produced from steam oil-presses, is, however, not so highly valued as that from the native oil-mills on account of the much smaller proportion of oil which it contains. As in the trade in all other oil-seeds, the loss to India by the exportation of seed instead of oil is very great.

III.—ADULTERATION OF THE OIL.

Adulteration.

This oil may be said to be more used in India as an adulterant for Sesamum (gingelly) and Cocoa-nut oils and in Europe for Olive-oil than being itself adulterated. Indeed for many purposes where these oils were formerly employed ground-nut oil may be said to have been found an efficient substitute. It is said to be used extensively at Coconada in adulterating ghí for export. It has been reported that occasionally when gingelly seed has been crushed and the bulk of the oil removed, a quantity of ground-nuts is added and the mill worked for a further period, when the oil so obtained is passed off as Sesamum oil.

DYE.

IV.—DYEING AND TANNING.

"In Europe, as well as near Pondicherry and at Panruti, the oil is used in various combination in the fixation of the red dye obtained from **Morinda citrifolia**. It is also employed in the process of tanning leather."

MEDICINE.

V.—MEDICINAL VALUE AND USES OF THE OIL.

In India this oil is officinal, and for all ordinary purposes may take the place of olive oil. It is understood that in Bengal, however, it is not the only oil used for that purpose, and that in Madras gingelly, and not ground-nut, is so employed. In the *Pharmacographia Indica* we are told that "in Bombay the oil is expressed at the Government Medical Store Depôt for pharmaceutical purposes to the extent of about 6,000lb annually. It is used as a substitute for olive oil. For making plasters the mixed sweet oil of the bazars may be used, but it requires rather more oxide of lead than ground-nut oil; the latter in the proportion of 90lb of oil to 41lb of oxide makes excellent plaster of a very pale colour and perfect consistence. Ninety pounds of bazar oil require 43lb of oxide." But according to **Bentley** and **Trimen** "the experiments of **Winter** in the United States show that it is well adapted for the preparation of cerates and ointments, but that it would not serve as a substitute for olive oil in the preparation of lead plaster. **Falieres** found it to possess great aptitude for the nitric solidification, hence he has recommended its use in the preparation of *Unguentum Hydrargyri Nitratis*. **Mr. Subba Rao** says that the UNRIPE NUTS are sweet and are given to women whose supply of milk is insufficient for their children; the unripe nuts are less oily and, therefore, more easily digested.

FOOD.

VI.—AN ARTICLE OF FOOD.

The oil is extensively used in India (especially in the Southern Provinces) for culinary purposes. Articles fried in ground-nut oil have an agreeable colour and flavour, and are said to keep well for a comparatively long time. As already remarked, it is also extensively used (in South India more particularly) as an adulterant for *ghí* (clarified butter), and in that form is therefore more extensively used in cookery than might at first sight appear. In Bengal it is largely used in the preparation of sweetmeats either pure or mixed with mustard oil, or mustard and sesamum.

Professor Church (*Food Grains*) says that the nutrient ratio of the ground-nut is 1 : 5·2 and the nutrient value so high as 151. But he adds that since half the weight of pea-nuts is oil, they require a considerable admixture of starchy food in order to become a wholesome and economical article of food.

Mr. Subba Rao has furnished some useful particulars regarding the KERNELS (nuts) as an article of human food. The following may be given as the chief points of interest in his remarks on this subject:—

"The nuts are said to be very bilious and unwholesome unless eaten in large admixture with other articles, more especially jaggery. They are,

FOOD.

however, extensively sold in the streets of Indian cities as an occasional article of food or luxury. For that purpose they are eaten roasted. The poor classes make sweetmeats by adding ripe ground-nut kernels to sweet palmyra juice and then boiling down to a thick consistence, and the richer classes by adding the kernels fried in *ghí* to a syrup made of brown sugar or cane jaggery. After being mixed with red gram in certain proportions, the nuts are also made into cakes (*Vadai* in Tamil). The roasted and pounded kernels are also eaten mixed with jaggery, or used instead of rice flour to give body to gruel. When quite fresh but not fully ripe, the nuts make an agreeable and comparatively wholesome food if boiled, salted and seasoned with mustard, chillies and *ghí* or oil. The ripe nuts are employed in the preparation of chutneys. Very tender LEAVES of the plant mixed with cocoanut scrapings are cooked as a curry by some Muhammadans near Cuddalore, and the curry is said to be palatable. The ground-nut CAKE reduced to meal is said to be mixed with other articles of human food in times of scarcity in order to give body to curries. In this way an adult is said to be able to consume about 2 pies' worth with a pie's worth of jaggery.

It is said that the roasted seeds make an admirable substitute for chocolate.

FODDER.

FODDER AND CATTLE FOOD.—As an article of food for cattle it may be said that the STEMS and LEAVES are regarded as a very nutritious fodder for cattle and horses, and whether fresh or dry are greedily eaten. But if the haulms get wet, *after being gathered*, they become unfit for use as fodder and in that case are employed as manure. The green fodder is largely utilized in the rains and constitutes a by-no-means inappreciable item in the value of the crop. But where labour is scarce and the nuts are accordingly allowed to remain in the ground after being ripe, the fodder is wasted, as the overripe crop cannot in that case be harvested in South India until after the first showers of the hot weather rains. The hay of ground-nuts is said to increase the flow of milk. A correspondent in one of the Madras papers has pointed out that the SHELLS of the ground-nut, if soaked in water and mixed with a small quantity of molasses, are eaten with great avidity by cattle. "In Pondicherry alone there is a large quantity of the shells of the ground-nut simply thrown away, but which could be utilized as a valuable forage. Some means may also be found to manufacture the same into compressed cake for exportation." Dr. Leather, on the other hand, has pointed out that the shells consist principally of indigestible woody fibre, and that on the careful exclusion of this part of the fruit will depend in a great measure the success of the earth-nut cake as a food for English stock.

Oil-cake.
Conf. with p. 29.

The OIL-CAKE is largely used as an article of cattle food, from 1 to 3½ lb being the daily allowance. According to Mr. Subba Rao cattle fed on this cake drink water very largely, and on this account it is regarded as specially valuable. Very rarely the cake is boiled before being given to cattle, and according to certain reports this is said to destroy the bilious character of the cake. But although the ground-nut is admitted to be very fattening and, on the whole, a valu-

FODDER.

able food for cattle, the opinion very generally prevails that it tends to produce certain diseases. Of this nature may be mentioned biliousness and night blindness, enlargement of the abdomen, dulness, hard-breathing, colic, and predisposition to anthrax. Jaggery and the leaves of the tree **Sesbania grandiflora** are given to counteract the bilious effects. A gruel of jaggery is also said to check night-blindness and the cattle are made to swim frequently as a cure for hard-breathing. A preparation of jaggery and milk is believed to counteract any tendency to anthrax.

According to some local opinion the milk of cattle fed on the cake is rendered insipid, but in the Saidapet farm, where cattle have for many years been supplied with the cake, **Mr. Subba Rao** says no evil effects have ever been observed.

VII.—MINOR USES.

MINOR USES.

Manure.

As a MANURE **Mr. Subba Rao** informs us "the cake is used extensively for paddy, sugar-cane and plantains, especially in the neighbourhood of Cuddalore. By all accounts the outturn is increased remarkably by its use, but all products raised with the cake as a manure are considered insipid. Rice, from a crop so manured, if kept after being cooked, it is said, ferments in a comparatively short time, so that it becomes disagreeable and unwholesome to eat, whereas rice produced from a crop manured with indigo refuse is very agreeable to the taste and keeps after boiling for a long time." But **Mr. Subba Rao** adds this opinion has not been confirmed by the results of special tests which were instituted to ascertain the influence of the cake as a manure on rice, though he adds that "if the supply of water to any crop to which ground-nut cake has been applied as a manure be deficient, the manure is said to do harm rather than good, making the crop wither much sooner than it would otherwise do. It is very curious that everywhere the ryots are of opinion that cattle fed on ground-nut cake and wet land manured with the same stuff materially deteriorate if the supply be discontinued." The stems (haulms) are often ploughed in as a manure, especially if the crop has from pressure of other work been delayed until past its natural harvest season or the haulms become fermented from rain. The shells are also believed to be good manure for wet lands, and the residual manurial value of the dung of cattle fed on the cake is regarded as very great. Indeed in the Report on the Experimental Farms of Madras for 1871 it is stated that "manure made by the consumption of a ton of cake is much more valuable than that made from the consumption of a ton of gram."

Fuel.

As a FUEL the shells find a ready sale particularly for use in tile kilns, and they are held to conserve the heat.

Storage.

STORAGE OF SEEDS.—The shells are also said to prove of great value in lining the bottom and sides of pits and other receptacles in which seeds are stored. This is said to ward off the attacks of white-ants.

The Ground-nut. (*G. Watt.*) | **ARACHIS hypogæa.**

VIII.—CHEMISTRY OF GROUND-NUT AND OF ITS OIL AND OIL-CAKE.

CHEMISTRY.

Seed.—**Church** in his "Food-grains of India" gives the following analysis of ground-nuts* :—

	In 100 parts.
Water	7·5
Albuminoids	24·5
Starch	11·7
Oil	50·0
Fibre	4·5
Ash	1·8
	100·0

Seed.

"The nutrient-ratio of ground-nut,"—*i.e*, the proportion of albuminoids to starch in its composition— says **Church**, "is here 1 : 5·2 and the nutrient-value so high as 151. As half the weight of pea-nuts is oil, they require a considerable admixture of starchy food in order to become a wholesome and economical article of diet. The green and unripe pods are less oily and more easily digested: they have an agreeable taste when roasted."

The seed, according to **Corenwinder**, contains in 100 parts 6·76 water, 51·75 oil, 21·80 nitrogenous substances, 17·66 starch with some nitrogenous matter, 2·03 phosphoric acid, potash, magnesia and chlorine.

Oil.

Oil.—In the *Pharmacographia Indica* it is said that "in Arachis oil, the commoner glycerides, palmatin and olein are partially replaced by the homologous glycerides of hypogæic and arachidic acids (*Allen*)." "**Kreiling**, besides separating arachic acid, obtained another acid which he identified with lignocerinic acid $C_{24}H_{48}O_2$, discovered by **Hall & Hermann** in 1880 in beechwood tar."

Oil-cake.

Oil-cake.—The following note on the feeding value of ground-nut cake was prepared by **Dr. J. W. Leather**, Agricultural Chemist to the Government of India :—

Conf. with p. 27.

"The seeds of **Arachis hypogæa** form, after being crushed and the greater part of the oil expressed, a cake which possesses valuable feeding properties.

"In Germany, France, and Belgium it has for some time been considered as one of the better cattle-foods, and although up to the present in England its consumption has been limited, the trade in it appears to be now developing.

"Like the refuse cake obtained by crushing other oil seeds, such as linseed, cotton seed, etc., it is of a decidedly concentrated nature, and the daily ration per cow or bullock only amounts to some few pounds.

* Compare with **Dr. Leather's** analysis, next page.

ARACHIS hypogæa. — **A Review of recent information on**

CHEMISTRY.

"Its composition naturally varies according to the amount of oil expressed from the nut, but the following analyses may be quoted in illustration :—

	Muler.	Voelcker.
Moisture	9·6	10·77
Oil	11·8	8·47
* Albuminoids	31·9	47·44
Starch, digestible fibre, etc.	37·8	22·27
Woody fibre	4·3	4·53
Mineral matter	4·6	6·52
	100·0	100·00
* Containing nitrogen	...	7·59

"These analyses show that the material is a highly nitrogenous food and the residual manurial value of the dung will be high, since the same contains the greater part of the nitrogen and mineral matter. It is well to point out, however, that these good qualities are attributable to the nut and not to the shell.

"The latter consists principally of indigestible woody fibre, and on the careful exclusion of this part of the fruit will depend in a great measure the success of the earth-nut cake as a food for English stock. Its separation before crushing presents no difficulties, and the cake, which has been latterly placed on the English market, has been fairly free from it. The following analyses of the shell and kernel, which I have made of a sample of the nut bought in the bazar, may be quoted as showing the differences that exist between them :—

*Conf. with p. 29.

	Shell.	Kernel.*
Moisture	7·35	4·70
Oil	2·80	49·25
* Albuminoids	7·57	29·09
Starch, digestible fibre, etc.	13·73	13·21
Woody fibre	55·35	1·65
Mineral matter	13·20	2·10
	100·00	100·00
* Containing nitrogen	1·21	4·65

Oil-cake as cattle food.

"In a report to which reference will be made immediately, Dr. Voelcker remarks: 'The principal objections to its use are that, owing to the rough method of pressure employed, the cake is often apt to have some amount of horse-hair and bits of rough sacking (from the bags used in pressing out the oil) attached to it, and that it is very liable to turn rancid and to become sour.'

"A comparative experiment on its value as a food for cattle was carried out during the winter of 1891-92 at the Royal Agricultural Society of England's Experimental Farm, the results of which (published in R. A. S. E. Journal, Vol. iii. T. S.) may be here appropriately quoted. Three lots of Hereford bullocks were fed during 107 days, the first receiving linseed cake as the concentrated food, the second lot beans, oats and barley, and the third, earth-nut cake, oats and barley; in each case hay and roots were also given *ad libitum*. At the commencement Lot I. received 6lb per head per day of linseed cake, which was gradually increased to 12lb; Lot II. received 6lb (2lb of each) of beans, oats and barley per head per day, which was gradually increased to 12lb of the mixture; and Lot III. received 6lb (2lb of each) of earth-nut cake, oats and barley per head per day, which was also gradually increased to 12lb.

The Ground-nut. (*G. Watt.*)

ARACHIS hypogæa.

CHEMISTRY.

Value as Fodder.

"The following tabulated statement shows the results :—

	Live weight gain per head per day.	Average carcass weight in 8lb stones.	Average price realised @ 4-8 per stone.	Cost of additional food per head.
		Stones. lb	£ s. d.	£ s. d.
6 Bullocks (Lot I) . .	2·03	101 2	23 12 6	3 17 10
6 Bullocks (Lot II) . .	2·01	100 2	23 7 8	3 6 9
4 Bullocks (Lot III) . .	2·19	99 7	23 6 3	3 4 0

"Having regard only to the actual gain in live weight, the earth-nut cake ration gave a somewhat better result than the others, whilst conversely it stands third in the list if the carcass weights be compared, the difference being, however, not great. If in addition the money values realised for each lot be considered together with the cost of the additional foods, the difference is likewise but trifling. It must be noted also that the prices of linseed cake and of earth-nut cake will vary according to the state of the market (that of linseed cake was £10-5 in the case cited) and such market fluctuations would readily alter differences so slight as the above."

In a pamphlet (issued very possibly by the trade) entitled "*How to Tell the Value of Feeding Stuffs*," it is pointed out (in connection with the above practical test) that "had a trial been made with equal quantities of brewer's grains and ground-nut cake, as against linseed cake, we should expect a different result, both as regards weight of carcass and cost of feeding." The gentleman who kindly supplied me with the above pamphlet has given the following analysis of Calcutta ground-nut cake alongside of which may be placed another analysis by Tuson :—

	Tuson.	Calcutta.
Water	9·58	10·10
Nitrogenous matter	42·81	48·55
Oil	7·40	9·16
Carbo-hydrates	27·63	22·53
Cellulose	7·87	4·73
Salts (ash)	4·71	4·93
	100·00	100·00

Professor Robertson (*Journ. Royal Agri. Society, September 1893*), after stating that he found horses throve best on a mixture of equal weights of this cake and corn,—the cake being broken into small pieces and steeped for 24 hours,—goes on to say that for fattening purposes for cattle "I do not know of any better food, in regard alike to its feeding value and to the superior quality of the beef produced."

TRADE:

IX.—FOREIGN AND COAST-WISE TRADE IN THE GROUND-NUT, AS ALSO IN ITS OIL AND OIL-CAKE.

Introductory.

INTRODUCTORY STATEMENT.—The figures of the rail-borne traffic having been briefly reviewed above, under the chapter of Cultivation (a course adopted in order to obtain some indications of the agricultural value of the crop), the present chapter may be devoted mainly to a consideration of the trade in the nuts, oil and cake, by sea both to foreign countries and to the provinces of India through exchanges effected coast-wise. It may be here mentioned that in the Resolution of the Government of India published on the 2nd November 1877, it is stated that "the exports of the nut to foreign countries in 1875-76 were, from Madras, 6,994 cwts. valued at R29,774 and from Bombay 3,721 cwts. valued at R13,845." These figures were very possibly defective and they certainly could not be advanced as denoting the total foreign trade for that year, since the exports from Bengal and other provinces, though, as a rule, trifling, would still have to be provided for in any attempt at a statement of the total export trade. As very possibly more fully manifesting the extent of the Indian trade some 20 years ago the following analysis of the total imports into France may be given:—

mports into France.

Imports of Earth-nuts into France from Western Africa, Senegal, British India, and French India for the years 1874 and 1875.

Countries whence Imported.		1874. Quantity.	1874. Value in Francs.	1875. Quantity.	1875. Value in Francs.
From West Africa	Kilos.	67,926,544	22,415,759	68,888,681	22,733,265
	Cwts. *1,336,166*			*1,355,092*	
„ Senegal .	Kilos.	22,823,548	7,531,771	19,795,971	6,532,670
	Cwts. *448,956*			*389,402*	
„ British India	Kilos.	Not separately distinguished.		1,231,803	406,495
	Cwts.		*ditto.*	*24,230*	
„ French India	Kilos.	1,262,910	416,760	6,404,899	2,113,617
	Cwts. *24,842*			*125,989*	
„ Other Ports .	Kilos.	9,255,425	3,054,291	5,203,114	1,717,027
	Cwts. *182,063*			*102,350*	
Total Imports into France . .	Kilos.	101,268,427	33,418,581	101,524,468	33,503,074
	Cwts. *1,992,027*			*1,997,063*	

From these figures it would thus appear that the exports of ground-nuts from India 20 years ago were a little over 150,000 cwts., for it may be assumed the bulk of the exports went to France. Last year (1893-94) the total Foreign Exports of earth-nuts from *British India alone* amounted to 1,536,905 cwts., of which France took 1,147,381

cwts. And it is significant that of these exports, 1,098,419 cwts. were sent from Bombay and only 436,335 cwts. from Madras. These returns, therefore, not only manifest an almost unprecedented expansion, but exhibit a remarkable migration of the foreign trade to Bombay. TRADE: French India.

In dealing more fully with the trade in ground-nuts and the oil therefrom, it may, perhaps, serve a useful purpose to isolate, from British India, so far as may be possible, the particulars available regarding

THE FRENCH POSSESSIONS IN INDIA.

IMPORTS.—**Mr. Subba Rao** says: "The foreign trade in the produce is centred in Pondicherry, though of late years a good deal has been done at Madras and Cuddalore. The greater part of the produce is exported in the form of kernels, which are usually packed in bags containing 164lb or 75 kilos. of seed. Most of the seed goes to Europe, but there is some export of seed in pod to Rangoon, the Straits Settlements and Ceylon. Seed in pod is never exported to Europe. During the year 1891-92 the total imports into Pondicherry were as follows:— Pondicherry.

Conf. with p. 13. Decline of Imports by Rail into Madras Ports.

Imports into Pondicherry.

DESCRIPTION.	IMPORTS BY		Total Imports.	
	Rail.	Road.		
	Mds.	Mds.	Mds.	Tons.
Seed	1,032,277	274,102	1,306,379	47,989
Oil	101,415	120,730	222,145	8,160
Cake	67,437	68,613	136,050	4,998

An attempt has been made (from the returned acreage devoted in the French Settlement to this crop) to estimate the production. But the above trade returns have now made it evident that either the area cultivated or the figures given for imports into the Settlement are considerably understated, since the amount available by these two estimates falls very far short of the amount known to be exported. *Conf. with p. 15.*

Before proceeding to discuss the export traffic it may be as well to give here some particulars as to the ruling prices of ground-nuts purchased in Pondicherry. A writer in the *Madras Mail* gives the following particulars as to the market quotations per French *candy* of 529lb:— Prices.

For	Highest.			Average.			Lowest.		
	℞	*a.*	*p.*	℞	*a.*	*p.*	℞	*a.*	*p.*
1887	...			21	0	0	...		
1888	27	12	0	20	10	0	18	9	0
1889	28	8	0	25	2	0	21	8	0
1890	27	8	0	24	5	0	22	9	0

ARACHIS hypogæa. **A Review of recent information on**

TRADE: Pondicherry. Nuts.

EXPORTS.—In dealing with the export trade from the French possessions in India it may be desirable to refer the returns to two sections, *viz.*, trade in the Nuts and in the Oil:—

I.—Export trade in Ground-nuts.

Exports of Ground-nut from French Possessions in India by sea.

	1891-92.		*1892-93.	
	Quantity.	Value.	Quantity.	Value.
	‡Candis.	₹	†Bags.	₹
TO FOREIGN COUNTRIES—				
France . . .	330,102=	51,87,552	206,256	29,83,041
Cwt.	*1,485,459*			
Straits Settlements .	26,517=	1,17,072	21,080	1,07,992
,,	*119,326*			
Other Countries . .	...	...	18	74
TOTAL .	356,619=	53,04,624	227,354	30,91,107
,,	*1,604,785*			
TO COAST PORTS IN INDIA—				
British Ports . .	46,435=	2,07,973	40	826
,,	*208,958*			
GRAND TOTAL .	403,054=	55,12,597	227,394	30,91,933
Cwt.	*1,813,743*			

Share of the French Possessions in India in the export trade in Ground-nuts.

	1891-92.		*1892-93.	
	Quantity.	Value.	Quantity.	Value.
	‡*Candis.*	₹	†Bags.	₹
From Pondicherry . .	377,492=	54,06,969	207,561	30,09,979
Cwt.	*1,698,714*			
,, Karikal . . .	25,562=	1,05,628	19,833	81,954
,,	*115,029*			
TOTAL .	403,054=	55,12,597	227,394	30,91,933
Cwt.	*1,813,743*			

* Latest returns received up to 1st January 1894.
† 1 bag kernels is said to = 1·46 cwt.; 1 bag pods to = 1·21 cwt. of kernels.
‡ 1 *candy* has been taken as = 500lb.

TRADE: Pondicherry. Nuts.

It will thus be seen that, roughly speaking, the exports of ground-nuts from the French possessions in India have, during the past twenty years, expanded from an eighth of a million hundredweight to considerably over 1½ million hundredweights. But the very greatest uncertainty exists as to the value of the returns published by the French authorities. On this subject Mr. Subba Rao says:—

"Accurate figures of the weights of the exports from French ports are not available, nor are those for the official year ending 31st March. But making use of such data as are available, it may be estimated that the gross exports from the port have in recent years averaged as follows:—

Five years ending in 1887	1,010,859 cwts.
Four years ending in 1891	1,219,350 „

"The season of 1891-92 was a bad one, and the crop smaller than usual."

Mr. Subba Rao then analyses the trade of 1891-92, but as the returns furnished to this office very recently do not correspond exactly with those given by Mr. Subba Rao, it is perhaps advisable to adhere to the more recent statement as having the probability of greater accuracy.

Mr. Subba Rao next discusses the total trade from Madras to foreign countries as well as coast-wise to the other provinces of India. He thus shows the figures of averages corresponding to those given above for the French possessions, *viz.*:—

Five years ending 1887-88	216,826 cwts.
Four years ending 1891-92	660,001 „

But the first of these two averages does not include the coast-wise transactions which at that period were regarded as too unimportant to be separately recorded. The comparison is, therefore, not quite accurate though it may serve the present purpose.

If now to these figures of averages a further quantity of, say, 200,000* cwts. of kernels be added—the amount equivalent to the quantity of oil exported—we arrive at a fairly good approximate of the South Indian export trade, *viz.*:—

1887-88 .	1,010,859 + 216,826 + 200,000 = 1,427,685 cwts.
1891-92 .	1,219,350 + 660,001 + 200,000 = 2,079,351 „

Oil.

II.—Trade in the Oil.—But it may perhaps be desirable in this place to furnish such further particulars as are available regarding the ground-nut oil trade of Pondicherry. This subject has from time to time been reviewed in the *Madras Mail* and much valuable information thereby made public. The following passages may be accepted as fully reviewing the available material. Mr. Subba Rao says:—

"A considerable amount of native-pressed oil is also exported, chiefly to Mauritius, Natal, the Straits, and Ceylon. It is estimated that one-fifth of the produce of South Arcot is retained for pressing locally. Oil is

* One hundredweight of seed is assumed to yield five gallons of oil.

TRADE: Pondicherry. Oil.

exported from Pondicherry either in Cochin casks or beer barrels. A Cochin cask contains $1\frac{1}{8}$ French candy or 5·25 cwts. A beer cask $= \frac{7}{8}$ French *candy*. To Rangoon oil is exported, as a rule, in Cochin casks and to Mauritius in beer barrels.

The exports of Ground-nut Oil from Pondicherry have averaged as follows:—

Periods.	Casks.	Estimate in gallons.
During the five years ending 1887 . . .	13,378	715,723
During the four years ending 1891 . . .	17,507	936,624
During the year 1892	13,510	722,785

"There has been a material increase in these exports of late years, and it must be remembered that 1892 was a bad year. The subjoined table shows the destinations of the exports in certain selected years."

Exports of Ground-nut Oil from Pondicherry.

Ports to which shipped.	1886.		1887.		1892.	
	No. of casks.*	Estimate in gallons.	No. of casks.	Estimate in gallons.	No. of casks.	Estimate in gallons.
Madras E. Coast ports .	2,133	114,116	1,782	95,338	85	4,547
Mauritius, Réunion and Natal	4,862	260,116	4,283	229,133	3,000	160,500
Ceylon	33	1,765	11	590	...	...
Straits Settlements . .	96	5,136	210	11,236	706	37,771
Burma	3,457	184,950	7,759	415,108	9,378	501,723
Marseilles . . .	5,169	276,541	...	...	...	...
Calcutta . . .	1,871	100,098	3,196	170,987	316	16,906
Other places . . .	2,309	123,534	47	2,516	25	1,338
TOTAL .	19,930	1,066,256	17,288	924,908	13,510	722,785

"The bulk of these exports of oil are therefore to Burma, whilst Réunion, Mauritius and Natal also take a large amount, and formerly also Calcutta."

The imports by British provinces recorded in Indian official statistics as derived from Pondicherry do not absolutely correspond with the above exports from Pondicherry, but the difference in the two sets of returns is not serious, so that they may be taken as substantially correct. The expansion of the export trade to Burma and the decline of that to Calcutta are significant features, the last being to some extent very possibly due to the growth of the Calcutta industry in expressing oil

Conf. with pp. 25, 38.

* One cask taken at $53\frac{1}{2}$ gallons.

The Ground-nut. (*G. Watt.*) ARACHIS hypogæa.

locally. In a notice on the Pondicherry trade which appeared in the *Madras Mail*, it is stated that crushing by steam machinery gives $3\frac{1}{2}$ per cent. more oil, and that the oil, moreover, fetches 4 per cent. more in the Indian, Burma and Straits' markets. To Pondicherry the trade is of the greatest value, for besides the employment which it gives to hundreds of families, the town benefits largely in co-operage, shipping, etc. It has also been pointed out that while the rate recently quoted for gingelly oil is ₹78, that for ground-nut oil is ₹81-8. Some few years ago the comparative values of these oils were reversed, *viz.*, gingelly ₹67 and ground-nut ₹59. This change is remarkable, since there would appear to be no doubt that gingelly oil is very much superior to that of ground-nut. The following may be given as the highest, lowest, and average prices per French candy of 525 lb for ground-nut oil during the years named :— TRADE: Pondicherry. Oil. Price.

	1875.	1880.	1885.	1890.	1892.
	₹ *a. p.*	₹ *a. p.*	₹ *a. p.*	₹ *a. p.*	₹ *a. p.*
Highest quotation .	49 0 0	70 0 0	67 0 0	85 0 0	86 0 0
Lowest „ .	32 12 0	51 14 0	52 0 0	56 0 0	69 0 0
Average „ .	43 0 0	59 8 0	55 14 0	62 0 0	75 13 0

The Pondicherry ground-nut oil trade has always been in the hands of native operators, and seeing that it represents a traffic of 12 lakhs of rupees in value, it is surprising that it has not secured European capital and enterprise. Foreign exchange affects the traffic to no appreciable extent, since the nut is grown in the country and the oil consumed locally. The greater part of the oil shipped from Pondicherry is made in British territory—Valavanur, a station on the Pondicherry-Villapuram Branch Railway, usually contributing about two-thirds of the total.

By way of contrast with these Pondicherry returns, it may here be added that the Madras Presidency exports of oil for the corresponding periods to those above were in 1887-88, 273,381 gallons, and in 1891-92, 50,760 gallons. But here a remarkable decline in the coast-wise trade with Burma, as also with Bengal, is manifested thus :—

Madras exports to Burma 109,920 gallons average for five years ending 1887-88 ; 10,539 gallons average for four years ending 1891-92 ; and 9,528 gallons for the year 1891-92. And to Bengal 138,890 gallons, 22,714 gallons and 8,922 gallons at the corresponding periods. The decline of the exports of oil to Europe is the natural expression of the fact mentioned above (p. 23), that the oil can be produced more cheaply in Europe than in India.

III.—Oil-cake.—In 1891-92, Pondicherry exported 900 tons of cake chiefly to the Straits, though some went to Ceylon. By way of comparison it may be here added that during the same year Cuddalore exported 1,200 tons of this cake to London. Oil-cake.

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TRADE: Coast-wise.

Coast-Wise Trade.

A difficulty exists in any attempt to produce a statement of the coast-wise trade in this article due to the fact that, while the imports from Pondicherry by British ports are regularly recorded by the receiving ports, the supplies drawn coast-wise by Pondicherry from British ports are not known with any degree of certainty. In other words, we can learn but very imperfectly the extent and character of the Pondicherry trade.

In analysing the coast-wise trade it may be referred to two sections: (*a*) trade in the nuts, and (*b*) trade in the oil—

Nuts.

(*a*) Nuts.—The total recorded imports of ground-nuts by all ports (excluding Pondicherry) during the past three years were as follows: 318,792 cwts. in 1891-92; 340,668 cwts. in 1892-93; and 359,194 cwts. in 1893-94. But on consulting the statistical tables, in order to learn from whence these supplies were drawn, we find the following as the chief items :—

Years.	From Madras.	From Pondicherry.	From Ports within the Bombay Presidency to Bombay.
	Cwts.	Cwts.	Cwts.
1891-92 . . .	69,306	5,906	240,265
1892-93 . . .	30,398	7,402	298,077
1893-94 . . .	24,686	12,397	319,270

It would thus seem that the provinces that are shown as receiving nuts from Madras have year by year been taking less and less, while from Pondicherry more and more. Of these Pondicherry exports, the supply to Burma has declined from 5,309 cwts. to 1,264 cwts., and that to Bengal expanded from 597 cwts. in 1891-92 to 10,999 cwts. in 1893-94. But the most striking feature of the returns of the coast-wise imports in these nuts is the very large amount drawn by Bombay from ports within that Presidency.

Bengal.
Conf. with pp. 25, 36.

It has been shown above that the imports by rail into Bombay town from the Presidency were in 1892-93, 1,233,866 maunds (or, say, 1,079,632 cwts.), and if to that figure be added the coast-wise imports, we obtain the total imports or supply of that year from which the foreign exports and coast-wise re-exports were made, *viz.*, 1,378,709 cwts. of seed (kernels). Before leaving the subject of the import traffic coast-wise in ground-nuts, it may be as well to give

TRADE: Coast-wise.

here a statement of the Bengal trade during the past three years :—

YEARS.	Total coast-wise imports into Calcutta.	PRINCIPAL SOURCES OF THIS SUPPLY.		
		From Madras.	From Bombay	From Pondicherry.
	Cwt.	Cwt.	Cwt.	Cwt.
1891-92	69,299	68,522	179	597
1892-93	29,665	26,737	...	2,899
1893-94	32,110	21,052	...	10,999

As there are no rail-borne imports into Calcutta, the above table may be accepted as representing the total amount consumed in Bengal less local production.

On turning to the tables of exports and in many cases re-exports coast-wise, it is found that Bengal practically retains the whole of her supplies; that Madras and Bombay are the exporting provinces; that the amounts shown above as consigned to Bengal are to all intents and purposes the exports from Madras, and they are the chief exports from Madras, since the Burma supply is very much smaller. But it is seen that Bombay not only does a large export trade with ports within the Presidency and to Sind (re-exports), but that considerable quantities are sent to the Native States of Cutch and Kathiawar.

(*b*) OIL.—Turning now to the subject of the coast-wise trade in ground-nut oil, it may be useful to exhibit the main features on the same plan as above for the trade in the nuts. Oil.

The following were the total coast-wise imports by British India of oil during the years 1884-85 and 1887-88, as also during the past three years :—in 1884-85, 496,060 gallons; 1887-88, 753,301 gallons; and in 1891-92, 838,850 gallons; 1892-93, 875,241 gallons; and 1893-94, 971,576 gallons. These supplies were drawn as follows :—

YEARS.	From Madras.	From Pondicherry.	From Ports within the Bombay Presidency into Bombay.
	Gallons.	Gallons.	Gallons.
1884-85	209,898	195,225	71,231
1887-88	89,484	539,274	95,316
1891-92	19,484	724,603	82,208
1892-93	11,853	770,981	75,040
1893-94	7,246	869,800	59,620

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TRADE: Coast-wise. Oil.

The most noteworthy feature of this trade is the expansion of the supplies drawn from Pondicherry and the decline of that from Madras. The decrease of the Madras coast-wise traffic in both the nut and the oil is therefore very significant. The Madras supply of oil to Bengal has fallen from 56,002 gallons in 1884-85; 32,976 gallons in 1887-88; and 8,901 gallons in 1891-92 to 3,934 gallons in 1893-94. The chief supplies of this oil, drawn by the various ports of India coast-wise, are derived from Pondicherry, and it may therefore be useful to exhibit some of the features of that particular traffic. Of the total recorded imports from Pondicherry by the Provinces of India shown above, the following may be mentioned :—

Years.	Imports by Burma from Pondicherry.	Imports by Madras from Pondicherry.	Imports by Bengal from Pondicherry.
	Gallons.	Gallons.	Gallons.
1884-85	180,742	193	13,228
1887-88	436,609	*Nil.*	102,665
1891-92	649,696	57,578	17,329
1892-93	748,483	3,150	19,348
1893-94	788,594	30,780	50,426

There would be an error involved, however, by this statement of the Pondicherry trade in ground-nut oil, were the reader not reminded of the fact that nearly the whole supply drawn from Pondicherry has already been shown (p. 15) to be carried by rail to that port town from British districts. It is, therefore, Madras oil that finds in the port of Pondicherry its most convenient exit to the great consuming centre—Burma.

Turning now to the returns of exports and re-exports (in order to form an idea of the amounts returned in the chief markets) it is seen that Bengal exports no ground-nut oil coast-wise (except very occasionally small amounts to Burma). The supply from Pondicherry to Bengal seems to be expanding very rapidly if the somewhat abnormal year of 1887-88 be excluded from consideration.

The exports from Bombay coast-wise are mainly intra-provincial exchanges (that is to say, from port to port along the Bombay Presidency), together with a small trade to non-British ports on the Konkan.

The Madras coast-wise exports in the oil are mainly to Burma, Bengal and ports on the Madras coast, while the exports coast-wise from Burma are from the chief to minor ports along the Burmese coast.

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TRADE: Foreign.

Foreign Trade.

As has been done in discussing the subject of the coast-wise trade, so it will be convenient with the foreign transactions to deal with the traffic in the oil and in the nuts separately. The following table may, however, be given in this place of the exports of nuts and oil side by side :—

Exports of Ground-nuts and Ground-nut Oil from British India (excluding Pondicherry) to Foreign Countries.

Years.	Nuts.		Oil.	
	Weight. Cwt.	Value. R	Gallons.	Value. R
1883-84 . .	712,954	37,65,462	6,308	6,349
1884-85 . .	676,460	36,14,063	14,457	14,787
1885-86 . .	655,670	32,86,115	4,410	4,417
1886-87 . .	945,895	42,15,748	5,432	4,806
1887-88 . .	1,261,637	61,18,436	1,671	1,612
1888-89 . .	827,997	47,89,813	224	1,671
1889-90 . .	1,394,191	81,38,649	9,620	11,014
1890-91 . .	1,525,238	87,73,290	13,374	15,053
1891-92 . .	1,529,940	87,58,508	30,703	33,633
1892-93 . .	1,524,796	1,06,30,342	11,600	16,188
1893-94 . .	1,536,905	95,97,275	20,973	28,745

The exports of ground-nuts expanded rapidly from 25,472 cwts. in 1878-79 to 265,743 cwts. in 1882-83. The figures for the subsequent years are shown in the above table. Alongside of these returns

TRADE: Foreign.

of exports it may be useful to exhibit figures of the import traffic in the oil from foreign countries—ground-nuts are not imported :—

Imports of Ground-nut Oil.

YEARS.	Gallons.	Value in rupees.
1883-84	125,938	1,63,998
1884-85	94,289	1,19,009
1885-86	166,342	2,13,694
1886-87	134,656	1,77,943
1887-88	517,727	6,14,857
1888-89	449,954	5,01,421
1889-90	8,058	11,463
1890-91	28,433	43,245
1891-92	12,376	18,447
1892-93	47,436	82,221
1893-94	5,445	8,356

The sudden decline of the foreign imports of ground-nut oil which took place in 1889-90 is very striking and may be due to the same cause that led to the discontinuance in 1887 of the exports of that oil from Pondicherry to Marseilles (see p. 36), *viz.*, the production of the oil in Marseilles at a price below what it could be purchased at in India. That is to say the discontinuance of the foreign exports may have thrown a larger surplus on the Indian markets and thereby checked the import traffic. In support of this view it will be seen above that the expansion of the Pondicherry consignments to Burma practically takes the place of the large supplies formerly drawn by that Province from the Straits Settlements. It is significant also that the exports from Pondicherry to Calcutta should have suddenly expanded in 1887-88 to 170,987 gallons and fallen off again rapidly to 16,905 gallons in 1892. Since then there has been a slight improvement in the imports by Bengal, but last year the supply was only about one-third of what it stood at in 1887. It may thus be admitted that the traffic in the nuts, as also in the oil, is one that often manifests the very greatest variations and may accordingly be characterised as a trade that has not become securely established, although it has made remarkable progress during the past twenty years.

It may now be convenient to review in some detail the foreign trade in the nuts, and subsequently in the oil. Since there are no imports of ground-nuts from foreign countries, it is only necessary to give the particulars of the export trade. For this purpose it will suffice to furnish an analysis of the returns from British ports during the past three years:—

Analysis of the Export Trade in Ground-nuts from British ports to Foreign Countries (e.g., *exclusive of the trade from ports in the French Settlement of India*).

Countries to which exported.	1891-92.	1892-93.	1893-94.	Provinces from whence exported.	1891-92.	1892-93.	1893-94.
	Cwts.	Cwts.	Cwts.		Cwts.	Cwts.	Cwts.
United Kingdom . .	45,069	38,009	107,553	Bengal . . .	84	...	2,047
Austria . . .	...	...	20,405				
Belgium	98,271	215,687	206,577	Bombay . . .	1,041,987	1,160,477	1,098,419
France	1,185,358	1,228,339	1,147,381				
Germany	8,074	6,213	6,998	Sind	138	80	97
Italy	74,845	7,000	15,998				
Spain	...	...	2,000	Madras . . .	487,668	364,235	436,335
Abyssinia	862	351	70				
Zanzibar	4	...	...	Burma . . .	63	4	7
Egypt	93,097	40	700				
Mauritius	8	6	18				
Natal	38	7	...				
Aden	1,039	1,457	1,677				
Arabia	2,045	2,505	2,243				
Ceylon	445	879	335				
Java	...	...	12				
Hongkong	56	186	...				
Mekran and Sonmiani .	242	122	193				
Persia	702	840	1,249				
Straits Settlements . .	19,679	23,065	23,288				
Sumatra . . .	2	...	...				
Turkey in Asia . .	104	90	208				
TOTAL .	1,529,940	1,524,796	1,536,905		1,529,940	1,524,796	1,536,905

TRADE: Foreign.

It will thus be seen that France drains fully two-thirds of the foreign exports and that Bombay is by far the most important seat of the export traffic from British India.

Turning now to the subject of India's Foreign trade in the oil it is found that there are both imports and exports as well as re-exports (that is to say, a portion of the foreign oil imported is again exported). It will be convenient to deal in the first place with the EXPORTS of INDIAN OIL and to take the returns of the past three years as a sufficient indication of the trade.

Analysis of the Export Trade in Indian Expressed Ground-nut Oil from British Ports to Foreign Countries.

Countries to which exported.	1891-92.	1892-93.	1893-94.	Provinces from whence exported.	1891-92.	1892-93.	1893-94.
	Gallons.	Gallons.	Gallons.		Gallons.	Gallons.	Gallons.
East Coast of Africa .	...	92	...				
Mauritius . . .	1,936	1,786	9,267	Bengal .	11,777	9,126	12,802
Natal	10,837	7,952	9,079	Bombay .	...	452	5,400
Réunion . . .	403	...	320	Madras .	18,926	2,022	2,771
Ceylon . . .	72	279	57				
Straits Settlements .	15,742	1,491	2,214				
Australia . . .	1,713	...	36				
TOTAL .	30,703	11,600	20,973		30,703	11,600	20,973

It is somewhat significant that Bengal should be the chief exporting province in this oil, but the traffic compared with that from Pondicherry is too unimportant to call for any special remark.

Turning now to the imports in this oil, it is found that practically the whole of the foreign supply is drawn by Burma from the Straits Settlements. The following table shows the traffic during 1887-88 as also the last three years:—

Imports of Earth-nut Oil from Foreign Countries by British India.

Countries from whence imported.	1887-88.	1891-92.	1892-93.	1893-94.	Provinces by which imported.	1887-88.	1891-92.	1892-93.	1893-94.
	Gallons.	Gallons.	Gallons.	Gallons.		Gallons.	Gallons.	Gallons.	Gallons.
China—Hong-kong	...	77	102	255	Bengal	...	58	80	245
Straits Settlements	517,727	12,299	47,334	5,190	Bombay	...	19	22	15
					Madras	...	...	...	...
TOTAL	517,727	12,376	47,436	5,445	Burma	517,727	12,299	47,334	5,185
					TOTAL	517,727	12,376	47,436	5,445

TRADE: Foreign.

The re-exports of foreign ground-nut oil are unimportant and need only be mentioned as an eccentricity of trade. Last year, for example, Burma returned 40 gallons of the oil to the Straits Settlements.

General observations.

By way of concluding this brief review of the trade in ground-nuts and ground-nut oil it may be said that it is difficult to arrive at any definite knowledge of the consumption in South India. There is a large local production, but the exports from that province are confused very considerably through their passing *viâ* Pondicherry. At the same time there is a much larger manufacture of oil in South India than in any other province, so that a comparison, for example, between Bombay and Madras in the traffic in ground-nuts is obscured on that account. Bombay is the chief seat of the foreign export traffic in the nuts from British India, and the accuracy of the returns already given can be tested by various methods. An estimate from the area of cultivation can easily be framed and the total production less the coast-wise and foreign exports would show the balance available for local consumption. The areas under the crop in Madras and Bombay last year were, for Madras, 247,797 acres and for Bombay, 184,620 acres. It is thus probable that the total area in India devoted to this crop does not exceed half a million acres. Though the acreage in Madras Presidency is actually higher than in Bombay Presidency, the amount of nuts carried by the railways to the sea-ports (including Pondicherry) is less than in Bombay. This fact may be taken as due mainly to the very considerable amounts used up in producing the oil which is shown separately in the railway returns. At the same time the South Indian local consumption of both nuts and oil may be higher than in Bombay.

Bengal exports no ground-nut oil coast-wise nor to foreign countries. The supply of oil drawn from Pondicherry to Bengal seems to be expanding very rapidly if the somewhat abnormal years of 1887-88 be excluded from consideration. The supply obtained from the Straits Settlements, though small, appears to be steadily expanding. It may thus be said that Bengal consumes the amounts shown above as derived from Madras and Pondicherry, plus the local production. Since the plant can hardly be said to be grown in Bengal, the imports coast-wise of ground-nuts may be taken as demonstrating the limitation of the local manufacture of the oil, there being at the same time no rail-borne imports of nuts. Last year the Bengal supply of this oil would thus appear to have been about 64,000 gallons—a fairly considerable quantity when viewed by itself, but quite insignificant when compared with the annual consumption in Burma.

As already remarked, Burma used formerly to draw very large supplies from the Straits Settlements, but within recent years Pondicherry has successfully contested the Burmese market. The annual supply obtained by Burma may be said to average 850,000 gallons. It is satisfactory to have to add, in conclusion, that up to the present date India has not drawn upon Europe for her supplies of this oil.

CALCUTTA:
1st December 1894.

A. 1261—70.

G. I. C. P. O.—No. 882 R. & A. D.—2-8-95.—2,000.—DE S.

(Agricultural Series, No. 4.)

THE

AGRICULTURAL LEDGER.

1893—No. 17.

DAIRY FARMING AND DAIRY PRODUCE.

(CREAM SEPARATORS.)

[*Dictionary of Economic Products, Vol. III.*, D. 14 a.]

INTRODUCTION OF EUROPEAN DAIRYING INTO INDIA.

Review of the Correspondence by DR. J. W. LEATHER, *Agricultural Chemist.*

THE following *précis* of the reports furnished by **Mr. E. C. Ozanne** and **Mr. J. O. Miller**, Directors of Agriculture, in Bombay and in the North-West Provinces and Oudh, has been drawn up by **Dr. J. W. Leather**, Agricultural Chemist to the Government of India.

At the suggestion of the Government of Bombay, the Dairy Supply Company sent Mr. Howman, a gentleman farmer, to India in 1889 to "ascertain by trial whether the Cream Separator is needed in India, and whether it can be profitably utilised in the manufacture of ghí."

After an extended tour in several provinces, and after having made various trials, the following results were arrived at:—

I. *Tak*, a bye-product of ghí-making, can be prepared perfectly well from separated milk. *Tak.*

II. *Mawa*, or *Khowa*, which consists of dessicated milk sweetened with sugar, can be made from separated milk, and the cream saved for butter or *ghí*. *Mawa.*

III. As much ghí can be made from "separated" cream as by the Native process. In June 1890, Mr. Ozanne, Director, Land Records and Agriculture, Bombay, obtained permission to employ Mr. Keventer, who had been Mr. Howman's assistant. Two separators were purchased and a dairy established in Bombay. During the year Mr. Keventer held demonstrations of the new appliances at various centres. Before April 1891, two dairies had been established in Bombay and one at Poona, under private management; and in the same year Mr. Ozanne was able to write as follows:—"The progress on the whole has been very satisfactory. One European regiment has become a large customer in its coffee shop, and it is a proof of the desire for good butter that the British soldier will pay one rupee per pound." *Ghí.*

DAIRY Farming. | **Introduction of European**

The sale of separators and other dairy appliances has rapidly increased since 1890.

The objects which Mr. Ozanne had in view in starting his experiments were briefly as follows :—

(1) To improve the quality of butter and other dairy produce.
(2) To provide hospitals and troops with a better milk supply.
(3) To study the feeding and milking qualities of different breeds of milch cattle.
(4) Experiments in the manufacture of cheese. There is a considerable import trade in European cheese; and it is hoped that the demand may be met eventually from Indian dairies.
(5) These objects are principally on behalf of the European population. The manufacture of Native dairy produce has already been referred to. Mr. Howman's experiments have demonstrated that the articles required by Native custom can be turned out by means of modern appliances, and the production of ghí, from separated cream, has been commenced.

From July 1891 to April 1893, Mr. Keventer continued his work in the North-Western Provinces, where two dairies, one at Aligarh and the other at Lucknow, were started under the direction of Mr. Miller, Director of Land Records and Agriculture. A demand for separated milk has already arisen, and it can also be converted into *mawa*. Not only has it been shown that the modern apparatus is an improvement on the old, but the demand for the produce has increased very rapidly. At Poona, for instance, from April 1st to 20th, 1891, the dairy issued 252lb of butter and 590 gallons of milk. At Aligarh in the six months, October 1891 to March 1892, over 6,000 gallons of milk were used, and 3,212lb of butter sold at 14 annas per pound, besides some cheese and cream. During the year 1892-93 the following were disposed of from the dairy :—

Butter	14,609 lb
Ghí	202 „
Cream	15 „
Cream cheese	81 „
Whole milk cheese	581 „
Skim milk cheese	185 „

A distinct and increasing demand for both cream and separated milk may be said to have arisen. This demand was at first limited to the European population, but in Bombay it is also extending to the Native community.

In his report for 1892-93 on the work of the two dairies at Aligarh and Lucknow, Mr. Miller writes respecting the Lucknow Dairy—"As the dairy got better known, purchasers for the separated milk were found, and before the end of April the morning supply of separated milk was insufficient to meet the demand." Moreover, apart from any indirect benefits which accrue, the dairies have been a financial success. The Commissariat Department, under contract with the Poona Dairy, made a saving of about ₹2,500 for the year 1891. The Aligarh Dairy in the first six months of its existence cleared all current expenses, and made a profit of ₹98 after allowing for depreciation of machinery. During the year 1892-93 the profit was ₹3,307. Both at Bombay and at Aligarh, students have been instructed in the use of the apparatus, and a number of private dairies have been started.

Records of the amounts of butter obtained from a given quantity of milk show that at Aligarh, in 1891-92, 58,200lb of milk were converted

into butter, and that that amount yielded 9,713lb cream and 3,281lb butter, or a ratio of 17·7 milk, 3 cream, and 1 butter. During 1892-93, the corresponding figures were: 275,050lb milk, 48,982lb cream, and 14,811lb butter, or a ratio of 18·5 : 3·3 : 1. But these quantities were obtained with mixed herds of cows and buffaloes.

Some analyses of both milk and butter have been made by the Agricultural Chemist to the Government of India. The milk of a herd of Sind cows and of a herd of buffaloes at Poona was analysed night and morning on eight occasions during July and August 1893, and the average of these analyses was found to be as follows:—

	COWS' MILK.		BUFFALOES' MILK.	
	4 A.M.	2 P.M.	4 A.M.	2 P.M.
Water	86·66	85·53	82·14	82·13
Butter fat	4·19	5·43	7·93	7·73
Casein	3·13	2·95	4·09	4·03
Milk sugar	5·31	5·40	5·05	5·31
Mineral matter	·71	6·9	·79	·80
	100·00	100·00	100·00	100·00
Specific gravity	1·0314	1·0297	1·0296	1·0292
Yield of milk in lb	8·0	5·8	6·1	5·9

Buffaloes' milk has always been understood to be rich, and the high percentage of butter fat shown in these analyses is therefore in accord with what was to be expected. The amount of fat in the cows' milk is, however, distinctly higher than might have been anticipated as compared with average yield from herds in Europe.

The analyses of the butter from Lucknow and Aligarh showed it to be excellent both as regards aroma and keeping qualities. A quantitative experiment was carried out at Aligarh in August 1892, to compare the amount of butter obtained by the European and Native methods respectively. The results were as follows:—

With European appliances 74lb cows' milk gave 3lb 6¼oz. butter, or 1lb butter from 21·72lb milk. So, again, 43lb buffalo milk gave 3lb 1oz. butter, or a ratio of 1 : 14·29.

With Native appliances 37lb cows' milk gave 1lb 7oz. butter, or a ratio of 1 : 25·74, and 11lb 12oz. buffalo milk gave 10¾oz. butter, or a ratio of 1 : 17·49.

Thus, by means of the European methods a larger outturn of butter was obtained both from cows' and buffaloes' milk. These butters were each analysed by the Chemical Examiner for the North-Western Provinces and Oudh, and the result showed that the quality of the butter made by European methods was distinctly superior. It contained considerably less water and curd than that obtained by Native methods.

During the hot weather some difficulty was experienced in sending butter to a distance by rail. A special box was first tried which had an ice-chamber in it, and butter was despatched to Naini Tal, Ajmere, and Lucknow in this manner during the hot weather of 1892. It has been

found, however, more economical and practical to send the butter in earthenware jars which have been previously rubbed with salt and soaked in water before despatch. Butter thus packed reached its destination in good condition after a journey of two days. In his report Mr. Keventer says that it is necessary to be careful not to *over* churn the butter *in the least*, if this result be desired.

The experiments with cheese have not been attended with quite the same success as have the other dairying operations. Cheese has been produced both at Poona and Aligarh, 1,930lb having been made at the latter dairy during the last year. The climatic conditions, both as regards temperature and moisture, are so different in India to those in Europe, that the difficulties to be overcome are considerable. There is, however, a demand among the European population for good cheese, and the experiments are being continued. Among the Hindu population there is a religious objection to cheese prepared with rennet. In order to overcome this, experiments have been tried with a vegetable rennet prepared from the berry of **Withania coagulans** and with some success.

The following Dictionary articles may be consulted in connection with this subject :—

Butter, *Vol. I.*, **B. 983.**
Dahí, *Vol. III.*, **D. 15.**
Ghí, *Vol. III.*, **G. 189.**
Rennet, *Vol. VI., Pt. I.*, **R. 73.**

The importance of the experiments briefly reviewed by **Dr. Leather** in the above notes can scarcely be overstated. It is sometimes affirmed that the Natives of India are very backward in adopting new ideas and new methods. The success that has attended the introduction of the sowing machine and of the sugar-mill may be cited in support of the view that they only require to have it demonstrated that their personal advantage is concerned in order to effect a complete reformation. The extent of the trade in Dahí and Ghí will be found fully indicated in the Dictionary articles mentioned above. If by cream separators or otherwise a larger yield of a better quality of these and other dairy produce can be secured, it seems likely the experiments dealt with above may in a very short period become established usages throughout the country.

A somewhat curious circumstance may be here mentioned of the use of a substance reputed to possess the merit of preventing milk from becoming sour. In the Dictionary article **Cocculus villosus**, Vol. II., p. 398, the following passage occurs :—' In Eastern Bengal the writer repeatedly observed the milkmen carrying milk to market with a few leaves of this plant and the spine-like leaflets of the date-palm placed in the vessel. On enquiry he was told these prevented the milk from getting bad through the heat and the shaking to which

it is subjected. He has never been able to investigate this point further, but it is probable the leaves of the **Cocculus** are added more with the object of thickening the water-adulterated milk. A large amount of the milk brought into Calcutta is regularly preserved or adulterated in this manner." It is well known that the leaves of **Cocculus** as of those of **Pedalium Murex** (*Faríd búti*) (see Dictionary, Vol. VI., Pt. I., p. 369) have the power of "thickening water" as it is called, but the action on milk, if the above observation be confirmed, seems well worthy the attention of the chemist and of the dairy farmer. **Pedalium** is reported to be more especially used to thicken butter-milk.

In a recent paper read at the Microscopical Society of Calcutta, **Dr. Simpson**, the Health Officer, exhibited the micro-organism which excites fermentation in milk and ultimately reduces it to an effervescent, sub-acid drink, known as the *kephir*. The kephir grains contain a rod-shaped bacillus and the budding fungus or yeast-plant. When introduced into milk, these two organisms multiply and, in conjunction with the lactic acid bacillus, cause the caseine to peptonise, and convert the sugar into alcohol and carbonic acid. Kephir possesses fattening and stimulating properties for which it is rapidly coming into use in Europe as a remedy for consumption. It has for long been regularly prepared and used in the Caucasus. It should be distinguished from *koumiss* which in the Steppes is made from mare's milk.

G. I. C. P. O.—No. 1303 R. & A. D.—3-5-95.—1,500.

(Vegetable Product Series, No. 9.)

THE

AGRICULTURAL LEDGER.

1893—No. 18.

MEDICAGO SATIVA—LUCERNE.

[*Dictionary, Economic Products, Vol. V.*, M. 336.]

LUCERNE CULTIVATION.

A Note by MR. JAMES MOLLISON, *Superintendent, Government Farms, Bombay, first published in 1892.*

Value as fodder.

LUCERNE **(Medicago sativa)** belongs to the **Leguminosæ**, and, like many forage plants of that Natural Order, sends its long tap-roots deep into favourable subsoils, particularly those of a calcareous character. It is recognised as one of the most valuable of fodder plants, resisting drought in an extraordinary way in those countries where it is grown without artificial watering. It shows its best results, however, under irrigation, and with a liberal application of suitable manure. In the neighbourhood of many military stations in India it is extensively cultivated and is sold at a high rate to form part of the daily ration of horses in hard condition. To milk cattle it can only be sparingly fed, ten pounds, the daily allowance for a horse, being also about the maximum quantity that can safely be fed to a milk cow. Its tendency to cause tympanitis is the danger that has to be guarded against in feeding it to ruminants.

Mode of cultivation.

I believe there is a better method of cultivating lucerne than that ordinarily practised. The usual plan is to broadcast the seed on a clean, well-prepared seed-bed, 16 to 20lb. per acre. Beds about 10 feet square are formed by raising a small ridge round each compartment with a hand-rake after the seed is sown. This operation also serves to cover the seed. A through water gutter runs between each double line of beds. These water-channels are therefore about 20 feet distant from each other. Their arrangement is regulated, however, by the evenness or otherwise of the field surface. Each compartment is flooded in turn, either by directing the water from an adjacent water-channel or by temporarily breaking the divisional ridge between two beds, so that water can pass from the one to the other.

Lucerne planted in this manner will yield heavy cuts for two or at the most three years. Meantime the land becomes foul with deep-rooted grasses and other weeds which the cultivator is powerless to suppress, and on this account the lucerne fails when it ought to be in full vigour. In this respect the country method resembles lucerne cultivation in England, where the plant is grown in rows on the flat 12—18 inches apart. By this process also the the crop is smothered after three or four years by a growth of twitch and weed in spite of periodical horse-hoeing.

MEDICAGO sativa. | **Note on Lucerne Cultivation**

It is important that the crop when fully established should last, because the initial cost of laying it down and subsequent outlays in manures are alike heavy. Seed alone costs ₹1-8-0 per ℔ or ₹24 to 30 per acre. Regular watering except in the rains is important. The crop thrives best in a friable loam with a limestone subsoil.

On the Poona Farm a plan of raising lucerne has been adopted which I first observed at Babugarh, near Meerut, and which I can unhesitatingly commend. The seed is sown on ridges which can be made 22 to 26 inches wide by an ordinary native plough.

In practice it will be found necessary to fashion the ridges afterwards into neat proportions with the hand-hoe. The slope of the surface of a field will indicate the direction in which the ridges should be drawn. Irrigation water must flow slowly along each furrow. If the inclination of a furrow is too great, soil and manure are swept to the lower levels of the field by the water gaining too much velocity.

Sowing. For the seed (which is best sown by hand) a rather deep groove is made with the corner of a light hoe along the top of each ridge; the seed is carefully sown and is carefully covered and should not be buried more than 1½ inch deep. The whole operation rounds and flattens the ridges and permits the seedlings to spring up in lines covering a width of 3 or 4 inches; crowding of the seedlings in a dense row is thus avoided. The importance of fine tilth is obvious, because the seeds are small. Frequent light waterings are required during the first fortnight, because the seedlings are delicate. They would probably wither, if exposed on the top of a ridge to a hot wind, unless sufficient moisture is within reach. This plan of sowing effects a saving of seed; 10℔ per acre is ample. In this connection, to avoid loss and waste of time it is wise to test the germinating power of seed to be sown. This can conveniently be done by noting the percentage of seeds that strike when kept in moist flannel for two or three days.

One object of sowing lucerne on ridges is to raise the stems of the plant out of contact with irrigation water. Under natural conditions, the plant requires very little surface moisture. Its great root-development enables it to collect enough in the subsoil, and therefore when water floods the crop as well as the soil, as in the ordinary bed system, unhealthy conditions are induced, particularly in low-lying places.

Weeding implement. The principal object aimed at in adopting the ridge and furrow system is to keep the field clean. The furrows can be weeded each time the crop is cut by using an ordinary bullock-hoe or a scuffler. I have found the American "Planet Jr." hoe—which with extra parts costs ₹33, obtainable from Messrs. J. Fleming & Co., Bombay—the best possible implement for this purpose. It is easily worked by two bullocks, and can be drawn by a rope or chain attached to an ordinary neck-yoke. If fitted with grubber tines in front, and an earthing-up double mould board behind, it grubs up weeds and earths up the ridges at an operation. It can be adjusted to any width of furrow over 18 inches. If manure is applied in the furrows every second cutting as it ought to be, it can be by means of this hoe incorporated with the soil and placed directly in contact with the roots of the crop. Moreover, the furrows are left clean, so that water can flow properly. Four cwt. of bones per acre and fifteen tons of well-rotted farm-yard manure applied some months before the seed is sown is a good preparation. At least five tons per acre of farm-yard manure, every second month thereafter, with an occasional top-dressing of bones, etc., or castor cake, are essential to continuous and increasing vigour of growth. With such treatment a crop on suitable land will be thoroughly established six months after sowing, and

Outturn. yield thereafter 11 to 13 cuttings in a year. The Poona Farm crop sown in June 1891 yielded between that date and the following March seven cuts. The last cutting, which was the heaviest, came to 6,034℔ per acre. This is

by Mr. James Mollison. MEDICAGO **sativa.**

equivalent to over 32 tons per acre in a year. This quantity at the current market rate of 100lb per rupee is worth approximately R717. Crops grown on this system have lasted for six years and over, and there seems no reason to put any term to a crop which is well looked after.

Seed.

If the lucerne crop is saved for seed, this should be done about the middle of the cold weather; water should be sparingly given for a month and withheld as the seed ripens. The object is to prevent a too succulent growth of stems and leaves, to encourage the formation of flowers and seed-vessels, and to produce plump seed that has slowly matured.

Arabian-grown seed is in some request in India.

Chemistry.

The chemistry of lucerne shows it to be of high nutritive value.

Lucerne in flower gives the following analysis:—

Water	74
Albuminoids	4·5
Crude fibre	9·5
Carbo-hydrates	9·4
Ash	2

[Much useful information on the subject of Lucerne will be found in the "Primer on the Cultivation of Lucerne" by Mr. E. Burke, of the Horse-breeding Department, Babugarh (Meerut Press, 1891).]

(Veterinary Series, No. 8.)

THE

AGRICULTURAL LEDGER.

1893—No. 19.

HORSE AND OXEN DISEASES—ANTHRAX.

[*Dictionary of Economic Products, Vol. IV.*, H. 414—436; *and Vol. V.*, O. 592.]

ANTHRAX IN INDIA.

Review of Official Reports; also a Summary of the more important opinions by G. A. OLIPHANT, Esq., *Principal Veterinary Surgeon in India.*

As some doubts have been raised whether true Anthrax is prevalant among horses, cattle, and sheep in India, a circular was issued by the Government of India in 1889, asking for reports from Veterinary Officers, which would settle the question whether the disease does or does not exist in India. A decision of this question was necessary before any comprehensive measures could be taken to introduce Pasteur's system of inoculation into India.

The general conclusion to be drawn from the reports here published is that anthrax does exists in India, both amongst horses and cattle. The subject is, however, under special investigation by the Superintendent of the Bacteriological Survey, to whom any information regarding it should be communicated.

It is very desirable that the diagnosis of the disease should invariably be confirmed by microscopical examination; and for this purpose cover-glass preparations, pieces of tissue in alcohol, and blood in sealed sterilised glass tubes, should, whenever possible, be forwarded to the Assistant to the Inspector-General, Civil Veterinary Department. But it should be recollected that it is necessary to take these preparations as soon after death as possible.—[G. W.]

Conf. with pp. 11, 12.

I.—MADRAS.

MADRAS.

Letter from the Inspector of Cattle Disease, Madras, No. 629, dated 11th June 1889, to the Board of Revenue, Madras.

I have the honour to state that diseases of an anthracoid nature exist among cattle and sheep in some of the districts in this presidency, notably in Tanjore and Chingleput; but, during my visits to the various parts of this presidency, I have not been able to meet with a single case among cattle and sheep, although I have visited many villages and districts where other epizootic diseases (rinderpest and epizootic aphtha) have been raging. The reason of this is that anthrax (in all its forms)

Rinderpest. Aphtha.

MADRAS.

is very rapidly fatal, and when the report of an outbreak of this nature is reported, it is generally after the subsidence of the disease.

2. There is not the slightest doubt in my mind but that anthrax exists in many parts of Southern India amongst cattle and sheep. I have had a large amount of experience with this disease among army horses at Secunderabad and Saint Thomas' Mount. Saint Thomas' Mount is situated in the district of Chingleput, from which district frequent reports of outbreaks of anthrax among cattle are received from the Stock Inspector. These reports refer to all cases of an anthracoid nature, and include cases of malignant sore-throat and quarter-ill, as well as, no doubt, of anthrax.

3. During the quarter ending 31st March 1889, 4,341 deaths of cattle and 1,147 deaths of sheep from anthrax (various forms) were reported from the whole of the presidency, and these figures go to prove that the disease is not a very prevalent one here, although it exists in many districts.

4. In the year 1887-88 one Stock Inspector reported considerable mortality among pigs and dogs having taken place at a village in the Nellore district after they had been feeding on carcasses of cattle which had died from anthrax. I hold strongly the opinion that the anthrax which causes so great a loss among army horses is due to the contamination of the lands from which the grass supply is obtained, by cattle suffering or dying from this disease; but I have as yet been unable to meet with cases of anthrax in cattle during my tours, and I have visited very many districts and villages in Southern India. In conclusion, I think that there is no doubt that this disease does exist in this presidency, but it is not very prevalent at the present time.

BOMBAY.

II.—Bombay.

Extract from a letter from the Principal of the Bombay Veterinary College, No. 577, dated July 1889.

Conf. with p. 15.

I have no evidence to hand which will establish beyond doubt that true anthrax does exist in the Bombay Presidency. I have no doubt it does. In the case of a recent outbreak among Government horses at Mhow, Veterinary Surgeon Meredith conclusively established the nature of the disease, and he expressed his opinion that it prevailed among cattle in the dominions of His Highness the Holkar.

Rinderpest: Foot-and-mouth disease.

2. Observers who are capable of making microscopical observations have found in this presidency that outbreaks of disease in cattle are generally either rinderpest, foot-and-mouth disease, or *Emphysema infectuosum*. In each of these disorders bacteriological research would be of much value, as also would it be in rabies and glanders.

PANJAB.

III.—Panjab.

Note by Mr. H. T. Pease, Veterinary Surgeon to the Panjab Government, dated 22nd June 1889.

Conf. with p. 12.

I have the honour to report, as the result of observations made during outbreaks at Umballa, Mustaphabad, etc., over a period of three years, that the disease attacking horses in India, and known by the name of Ludhiana disease and anthrax fever, is true anthrax. This disease is a

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systemic disease characterised by certain alterations caused by the presence of a bacillus in the blood and differing from *Charbon symtomatique* in several essential particulars.

In many cases death results without any external manifestations at all. But in those cases in which œdematous swellings do appear, they offer certain distinctive features from those present in *Charbon*. They do not appear so localised, are not black on incision, and do not become painless, nor do phlyctenæ appear on them. They remain, as a rule, hot, tender, and somewhat tense, and are the result of the exudation of citron-coloured effusion into the subcutaneous connective tissue. Crepitations are invariably absent, forming a very distinctive feature between them and those seen in cattle suffering from *Charbon symptomatique*.

I do not remember ever having seen a case of *Charbon symptomatique* in the horse, and in one case only, so far as my memory serves, did I find crepitations present in a case of anthrax, and that only immediately before death. The anthrax attacking horses is a very fatal disease, the rate of mortality being very high, excepting when it occurs in those places where it is enzootic, when I am of opinion that, as a rule, it is much milder and may be combated to a certain extent by antiseptics. An organism is undoubtedly present in the blood of animals which have died of the disease, but whether it be the **Bacillus anthracis** or not I am unable to say, not having sufficient experience in the science of bacteriology, and I am inclined to think that any opinion founded only on what is seen under the lens [1] without the tests laid down by Koch being performed are liable to be unreliable and misleading.

With regard to cattle, the disease known to us as splenic apoplexy is unfortunately but too frequent and fatal, almost all animals attacked succumbing and great losses ensuing to the zamindars; charbonous disease, as galghotu, gloss-anthrax and black-quarter, being also very common. In the latter disease the tumor is undoubtedly charbonous, presenting all its distinctive characters of crepitation, callosity, and dark colour when incised.

This latter is not nearly so fatal as the former, known as splenic apoplexy, which I am inclined to think is true anthrax. I have not met with the disease in sheep at present.

Note by Captain Marrett, Superintendent, Government Cattle Farm, Hissar, dated 5th August 1889.

My experience with the diseases which we have hitherto classified as anthrax (with regard to cattle) shows that—

(1) the affection is almost invariably localised;
(2) when an incision is made of the œdematous part, it presents a dull, dark red, almost black appearance;
(3) death almost invariably takes place within 24 hours;
(4) limping before death is invariably present, except in those cases where the parts affected are either the stomach or lower part of the neck;
(5) the swelling under the skin of the affected part is found to crackle under pressure of the fingers.

Taking these symptoms and after reading Mr. Mukerji's Note on Vaccination Charbonneuse, I should have no hesitation in stating that the disease was not "anthrax" but charbon as described by Mr. Mukerji.

[1] The Bacillus anthracis, compared with other pathogenic organisms, is of very considerable size.

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But against the foregoing must be placed the following facts:—

(1) that many of the animals that die from what we suppose is "anthrax" are found to bleed from the anus and nostrils at the time of death: these cases are generally those in which the disease has exhibited itself internally,—*i.e.*, in the stomach or lower part of the neck or chest;

(2) that the blood taken from the heart, spleen, and liver of a cow supposed to have died from anthrax was subjected to microscopical examination by a veterinary surgeon specially deputed to make the investigation, and I understood him to say that the true anthrax bacillus was present in the blood examined.

Examination under the microscope seems to be the only means of determining whether the spore is **Bacillus anthracis or Bacterium Chauveau**, and therefore whether the disease is true anthrax or ordinary charbon. I, of course, express the opinion with great diffidence, but I think the weight of available evidence we at present have is in favour of the disease being charbon and not anthrax, so far as the cattle here are concerned.

The Government Farm is, I am sorry to say, a heavy loser by the periodical outbreak of this disease, whatever it is, and offers exceptional facilities for experiments in the way of inoculation with the vaccine which I notice from Mr. Mukerji's notes is procurable from MM. Marais et Fromage, droguistes, Rue Lebrim, Paris. I would therefore take this opportunity of suggesting that you secure, through the Agricultural Department, a certain quantity of the charbon vaccine, with a view to experiments being carried out here under a selected local committee. The disease is one that does not yield to treatment, and the only hope, therefore, is in its prevention.

Note by F. Joslin, Esq., Veterinary Surgeon, dated 16th August 1889.

Conf. with p. 15.

During the month of July 1889 three cases of anthrax were brought to my notice while on leave at Murree. Two of the cases which occurred in the early part of the month were ponies, the property of Lieutenant Hopkins, Seaforth Highlanders; the other case was a pony which died in the bazaar, and of which I made a *post-mortem* examination at his request.

The two former presented the symptoms and *post-mortem* appearances of true anthrax, and the latter the *post-mortem* appearances of a malignant case of true anthrax.

No. 64-V., dated 11th March 1883.

From—J. A. Nunn, Esq., Veterinary Surgeon, on Special Duty,

To—The Deputy Commissioner of Multan.

Conf. with p. 12.

I have the honour to inform you that on the 20th and 29th February I visited the Sarai Sidhu tahsil of your district with the object of investigating the nature of the diseases that have recently caused such loss amongst cattle. I met the Tahsildar at Talamba, and he furnished me with the police reports relating to cattle diseases for the last three months, and from these I gather that it is not confined to the Sarai Sidhu tahsil alone, but is spread all over the district of Multan, and also ascertained it extended to Muzaffargarh district as well. It would further appear that not only is cattle plague (rinderpest) rife, but also foot-and-mouth disease (eczema epizootic), splenic apoplexy, etc.

In the police reports the names of the diseases are given, but several of them are in the Multani *patois*, and are quite strange to me, as I am

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ignorant of the local dialect; and, though I endeavoured to obtain a description of the symptoms, etc., from the *lambardars* or headmen who were assembled at Talamba and Sarai Sidhu, they were so confused, and the account of one individual so totally at variance with that of another, that I was unable to arrive at any satisfactory conclusion. I am induced, however, to believe that different names are used in different villages for the same disease, and not only that, but that very frequently wrong names are given by the owners, who are mistaken as to the particular disease their animals are suffering from. As an instance, I may mention that the *tashildar* and all the other Natives I met at Talamba stated that the disease known to them as *peer* was nothing but that form of foot-and-mouth disease (eczema epizootic) in which ulcers are found only on the dental pad and tongue,—the other form, in which both the foot and mouth are affected, being known as *manh khor*.

Rinderpest.

On the 1st February I was informed that a buffalo was ill from *peer* at the village of Ranipur, near Salarwahan, in the Sarai Sidhu tahsil. I at once went out and examined the animal, and found it to be a case of cattle disease (rinderpest), all the people being quite ignorant as to what it was. I may as well add that in this village I was told by the headman that there were about 150 head of horned cattle, more or less. The owner of the sick buffalo I saw had lost two a few days before, being the first cases that had appeared in the place. His house was in the centre of the village and the cattle were kept in an enclosed courtyard with a shed in the corner. Both the animals he had lost had died in this shed; but still so ignorant are these people that not only had the third one I saw been put into the same place, but the door was open, and several other animals in the courtyard were allowed free access to the place where this animal was suffering with rinderpest.

Cattle Diseases.

Diseases mentioned in the police reports are no less than 15 in number,—*viz.*, 1, *sang*; 2, *mohara*; 3, *galghotu*; 4, *baki*; 5, *sat*; 6, *tap*; 7, *pani lag*; 8, *chechak*; 9, *kalawah*; 10, *jola*; 11, *zahmat*; 12, *peer* or *pír*; 13, *kapoli*; 14, *seemak*; 15, *kaunsi*; 16, dysentery. The mortality and extent of these diseases is shown in the following table:—

No.	Diseases.	Cases.	Recoveries.	Deaths.
1	Sang	28	...	28
2	Mohara	362	359	3
3	Galghotu	406	68	338
4	Baki	552	169	383
5	Sat	48	14	34
6	Fever (tap)	13	9	4
7	Pani lag	809	191	618
8	Chechak	189	149	40
9	Kalawah	129	4	125
10	Jola	1	...	1
11	Zahmat	13	7	6
12	Peer	3	...	3
13	Kapoli	1	...	1
14	Seemak	29	9	20
15	Kaunsi	1	...	1
16	Dysentery	1	...	1
	TOTAL	2,585	979	1,606

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By this it will be seen that the deaths are 1,606, recoveries 979, and cases attacked 2,585, the most fatal being those known as *pani lag*, *baki*, and *galghotu*. As I have before said, I do not think that there are 16 different diseases rife amongst the cattle of the district, but that many are different names for one disease. Many of these names being in the Multani dialect are strange to me, and the statements of the zamindars are somewhat confused and contradictory. I have not been able to ascertain the true nature of all, but of such as I have I propose to give a brief description, with the treatment and preventive measures to be adopted.

Sang or *Sat*= Black-Leg, or Black-quarter.

1st. *Sang* and *sat* appear to be one and the same disease, which is known, in the Fens of Lincolnshire, as Black-Leg or Black-Quarter (Carbuncular Fever). This belongs to the class of anthracoid or charbonaceous diseases that have lately been attracting so much attention both in England and on the Continent. The true nature of these diseases has not yet been satisfactorily ascertained, but, as far as is known, is decomposition or disarrangement in the constituent parts of the blood, caused by the presence in it of a minute organism only visible under a highly magnifying microscope. The exact nature of this organism or bacterium, whether animal or vegetable, has not yet been discovered; but by experiments performed on the Continent it has been proved that anthrax can be conveyed from one animal to another by direct inoculation into the blood, and also by the digestive track and the mucous membrane,—that is to say, by the virus being conveyed in the food and water and in the air. Fleming, the latest authority in England, writing on the subject, says:—

"This is the most universal disease we are cognisant of as affecting animals, attacking as it does even birds and fishes: also domesticated as well as undomesticated animals suffer from its effects, though it appears that certain among them have a predisposition to its direct primary or spontaneous development. These are the herbivorous mammals, particularly solipeds and ruminants. In carnivorous and omnivorous animals, with the exception of the pig, this mode of production has not yet been fully established, yet it is transmissible to those and to mankind by inoculation and other ways. Anthrax or carbonaceous diseases are manifested in bovine, ovine, and caperine animals in five forms, *viz.*, 1, black-quarter; 2, splenic apoplexy, which is known amongst natives as 'goli'; 3, abdominal or anthrax; 4, gloss-anthrax, known as 'galghotu'; and 5, malignant sore-throat. These primary are all due to dietetic errors, one of the chief being allowing the animals to graze on land that is marshy, or that has been flooded, and on exposure to the sun a great growth of rank luxuriant vegetation takes place. It is also caused by suddenly over-feeding animals that had before been half-starved."

Black-quarter—which is also known as Black-Leg—derives its name from the fact that generally it is the extremities that are attacked, and that on a *post-mortem* examination the tissues are found to present a dark or black appearance; it, however, also makes its appearance in other portions of the body. It commences with high fever, the mouth, ears, and horns being hot, the mouth and muzzle dry, the pulse feeble and irregular and very rapid, sometimes going up to 80 or even 120 beats per minute, and severe shivering fits; swelling appears on the parts attacked—that is, the limbs, quarters, chest, dewlap and ribs, which on pressure emit a cracking sound due to the formation of gas in the subcutaneous tissues. If these are cut into, it is found that they are full of fœtid gas, and black necrosed blood-clots mingled with a thin prurient fluid. The animal rapidly sinks, generally dying in a very short time.

Splenic apoplexy.

2nd. *Splenic apoplexy.*—The causes of this disease are the same as of black-quarter. Death takes place very suddenly, the animal that was quite well a few hours before being often found dead, apparently having succumbed without a struggle. Should, however, the disease not have been so rapid in its course, some premonitory symptoms may have been

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noticed, such as general uneasiness, high fever, hurried breathing, quick irregular pulse, and a dark or red appearance of the urine. These symptoms, after continuing for some hours, subside, but only to return, when as a rule the animal dies. Generally in these cases the spleen presents the most striking *post-mortem* appearances; its internal structure is broken down, the organ is generally enlarged and much distended, being filled with a quantity of semifluid, dark, tar-like blood. This blood will gravitate to the lowest portion, showing that the tissue is broken down. The liver, kidneys, and the mucus membrane of the digestive canal are also somewhat involved, but to a lower degree.

The abdominal or enteric form, as far as I am aware, is not seen in the Punjab; at least that is my experience up to the present, although it is quite possible that it may exist. I shall therefore dismiss this subject with a few remarks. According to Professor Williams of Edinburgh, the most prominent sign is the passage from the bowels of quantities of dark-coloured blood, and the characteristic *post-mortem* appearances are congestion of the intestinal mucus membrane, more specially of the small intestines, which are covered with *petechial* spots with incipient ulceration in their centres, extravasations of dark-coloured blood into the canal,—*i.e.*, the bowel,—and very often extravasations of blood into the sublumbar areolar tissue, the fatty mass surrounding the kidney being loaded with extravasated blood in a disintegrated or broken-down condition, or covered with *petechiæ*.

Gloss anthrax, or *Galghotu*.

3rd. *Gloss-anthrax.*—As far as I can at present determine, this is the disease known by the local name of *galghotu*, although in the swelling of the throat that takes place this latter presents some difference. Gloss-anthrax differs from the previously-described forms of anthrax in the region it attacks,—*viz.*, the tongue and fauces, giving rise to the appearance of a number of vesicles on the tongue and palate, and even the cheeks. These vesicles increase in size and at length break, forming ragged, indolent ulcers. The tongue is tumified and soon becomes swollen and hard; the animal evinces great pain, and there is a copious discharge of saliva from the mouth mixed with blood, and a thin acrid fluid from the ulcers. All the local symptoms that I have described as accompanying black-quarter are present,—*viz.*, constitutional fever,—and the animal usually succumbs to the effects of the disease in about 48 hours, if not asphyxiated before.

It will be seen from these remarks that anthrax is entirely a blood disease and caused by defective feeding, and also that the administration of such drugs as could be procured by a zamindar in the bazaar are not likely to have very much effect, and that operations should chiefly be directed to preventative measures. The chief of these would be to induce the farmers to reserve a small quantity of dry food, such as *bhoosa* or *kherby*, and give each animal a portion during the period that the grass begins to spring after the rains, and also to those that were grazing in marshes. A seton inserted in the dewlap has undoubtedly good result, and in the low-lying parts of England where anthrax is rife is extensively used as a process of precaution. It is a simple operation, and can be performed by anyone who is provided with a proper seton needle, which is a piece of flat steel, about nine inches long, sharp at one end and inserted into a wooden handle; and at the other, about a quarter of an inch above the point, an elongated hole is made. The seton can be made of a piece of tape, a strip of cloth, or even thick cord can be used.

The operation is performed as follows:—The animal being secured, a portion of the loose skin of the dewlap is firmly grasped in the left hand, and the point of the needle pushed through. It is inserted under the skin

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into the loose connective tissue, between it and the muscles, for about six inches, and again brought out so that a portion is transfixed.

The tape or cord is then passed through the eye of the needle, which is drawn back, leaving the seton in the wound. The two ends are tied together, or, what is preferable, a piece of wood is tied transversely across each to prevent its being drawn out : this is the better plan, as thorns, etc., are liable to catch in the loop formed if the two ends are tied together. The action of the seton is increased if the tape is dressed with some irritating liniment, such as turpentine ; but if this is not procurable, mustard oil or *chir* (pine) oil would do. The seton should be pulled backwards and forwards two or three times a week, freshly dressed with whatever oil is used, and the wound cleaned. When the disease has made its appearance, even in England, with every remedy at hand, the mortality is very great ; still, however, if active measures were taken, much might be done. The swelling should be fomented with warm water, and the surrounding parts stimulated by being well rubbed with mustard oil, and the following drink be given : warm ghee, pint ; country wine, 2 ounces ; nitre (*shora*), 1½ ounces ; these two latter to be given night and morning in a quart of gruel as long as the animal is ill.

Mohara.

4th. *Mohara* (eczema epizootic), which is known in other parts of the province as foot-and-mouth disease, is of a febrile, highly contagious and infectious nature, characterised by the presence of a number of vesicular eruptions in the mouth, between the cleft of the foot and round the coronet, and in cows at the udder. The period of incubation varies from 24 hours to 4 days. If common precautions and ordinary care are taken, the mortality is almost *nil*; but natives always neglect their animals when ill so much that the losses are enormous. When the vesicles in the mouth break and develop into ulcers, the animal is unable to eat hard, dry *bhoosa* or *cherry*, and literally dies from starvation. The animal when sick should be drenched with gruel made out of *atta*, or any sort of flour that may be at hand ; about a pound mixed in a quarter of water should be given two or three times daily, and every other day an ounce of saltpetre (*shora*) should be put in the gruel.

If the animal will not drink itself, which it seldom will do, the gruel should be given from a bottle or a horn. The ulcers in the mouth should be washed daily with a lotion made of an ounce of powdered alum to a pint of warm water ; and those in the feet dressed with powder alum, and well cleaned daily. If these few simple precautions are taken, mortality would be very low indeed.

Baki.

5th. *Baki* is said only to attack goats. The animals were described to me as suddenly throwing up their heads, uttering a peculiar bleat, from which the name of the disease is derived, and then falling down dead. These symptoms almost exactly correspond with those exhibited in splenic apoplexy in cattle (called in Hindustani *gali*). The treatment and preventive measures would be the same as given under the head of that disease.

Pani lag.

6th. *Pani lag.*—I have not been able to arrive at any satisfactory conclusion regarding this disease, which, from the returns given to me, appears to have caused more loss than any other.

It would appear to be caused by cattle drinking the water left in pools and hollows from floods and the rain, and which has become putrid ; but whether it is an obscure form of anthrax fever, or is, as the Natives affirm, caused by bad water, I cannot say. It is said, however, to be more prevalent during the hot weather than the cold.

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7th. *Kalawah*—called in other parts of the Punjab *wah* and *gahmat*—is rinderpest, or what is generally known as cattle plague. The symptoms are briefly as follows, but all are not invariably present, and in this country they are often very obscure :—

Kalawah or Rinderpest.

Rinderpest is a contagious and infectious febrile disease, having an incubative period of from 7 to 14 days. At first but little is seen, except the symptoms of ordinary fever,—*viz.*, dullness, want of appetite, staring coat, and in milch cows suppression of the secretion of milk. After about 24 hours the animal begins to tremble, with an arched back and drooping ears, as if suffering from cold; the head is drooping and an unmistakeable appearance of illness, purging commences, and eruptions are seen in the mouth, resembling those seen in foot-and-mouth disease. The membranes of the eyes are reddened, with a thick discharge from them that hangs about the face, and there is also a discharge of thick mucus from the nostrils that dries up and impedes breathing.

In the females the vagina assumes the same appearance as the mouth, beginning with a pink colour, rapidly deepening to purple, and finally discharging a thick secretion. In some cases an eruption is seen on the skin, particularly under the elbows, and on the inner aspect of the thighs. I have therefore come to the conclusion that the term *chechak*, which is also used for small-pox in the human being, or any eruptive disease, is only another name for cattle plague when it assumes this peculiar form. Another most important symptom is the very peculiar smell about a sick animal that is altogether unmistakeable, also the increase in temperature, which in the normal state in the ox is about 100° Fahrenheit, but in cattle plague is raised to 103° or 104°. As a thermometer is required and some skill in the use of it, it is not necessary to enlarge on this point. As for treatment, medicines have no effect as specifics, and as from religious scruples it would be impossible to attempt the measure so successfully adopted in England of stamping out, the only precaution that can be taken is that of isolation; and I have no doubt that, if properly and thoroughly carried out, the mortality would be lessened. Until the Government will frame some legislation and system of enforcing it, it is hopeless to expect any abatement of the disease.

Seemak.

8th. *Seemak* has only been reported amongst horses from one village in the Alipore tahsil, and is confined to horses. It is undoubtedly that form of anthrax fever known as Ludhiana fever.

I regret that I should not have been able to collect further information as to the other diseases mentioned, and also that what I have is so very superficial. But I trust before long to be able to pay another visit to the Multan district, and to make a fuller investigation.

No. 225-V., dated the 26th January 1885.

From—J. A. Nunn, Esq., Veterinary Surgeon to the Punjab Govt., Lahore,

To—The Junior Financial Commissioner of the Punjab.

I have the honour to return the file on the possibility of introducing preventive inoculation for anthrax in cattle according to M. Pasteur's method in the Punjab, and after perusing M. Chamberland's work and the others enclosed, I have arrived at the following conclusions :—

1st.—That it has been demonstrated the preventive inoculation of animals against anthracoid diseases can and has been practised with success in France and Germany, and without doubt the same could be done in India.

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2nd.—That from the subtle nature of the artificially-prepared anthrax vaccine, it could not with safety be imported, but would have to be prepared in India.

3rd.—Owing to the delicate process that has to be gone through in this preparation and the disastrous results if not properly attended to, a special laboratory under skilled European supervision would be required; and furthermore the lymph could not, I think, be trusted to natives to vaccinate animals without supervision.

4th.—The question appears to me to resolve itself into a purely financial one, and to lie with the Government of India to decide whether the expense of cultivating lymph and vaccinating animals can be met, or whether it is preferable that the present loss to the country in the death of animals from preventible disease is to go on unchecked, and this manner of expenditure is one on which I am not competent to give an opinion.

5th.—In conclusion, I would beg to remark that I have submitted the correspondence in question and this letter to Mr. Kettlewell, and he fully agrees with me.

No. 241-V., dated the 17th February 1885.

From—J. A. Nunn, Esq., Veterinary Surgeon to the Punjab Govt., Lahore,

To—The Officiating Junior Secretary to the Financial Commissioner, Punjab.

I have the honour to inform you that the police reports, copies of which have been submitted quarterly to the Junior Financial Commissioner, Punjab, show from 1st October 1882 to 31st September 1884 that the total number of animals reported is as follows:—

Seizures	30,137
Recoveries	10,523
Deaths	27,296

Out of these—

Seizures	16,407
Recoveries	3,945
Deaths	11,120

are from diseases that, although returned under Native names, I know to be of an anthracoid nature, leaving—

Seizures	13,730
Recoveries	6,578
Deaths	16,176

to other causes.

I would beg to remark that under this head I have shown those diseases that have been returned under Native names, the nature of which I am unacquainted with, so that the percentage of deaths from anthrax would probably be greater than the numbers I have given. I would also beg to remark that, from my personal observations, I am perfectly satisfied that these police returns are most incorrect, and do not present one fourth of the actual number of casualties.

BURMA.

Conf. with p. 18.

IV.—BURMA.

Nos. 8828 and 8852, dated the 3rd and 7th June 1889.

From—R. F. Frost, Esq., A. V. D., Veterinary Instructor,

To—The Financial Commissioner, Burma.

The mortality from anthrax is not so great in this province as to call

for any such measures as those indicated in the Note on Vaccination Charbonneuse by Mr. N. G. Mukerji. BURMA.

I have frequently satisfied myself, by microscopical examination, of the presence of the Bacillus anthracis in the tissues of animals that died of anthrax. I do not think that the disease exists to such an extent as to warrant the introduction of M. Pasteur's prophylactic measures into Burma.

V.—Berar. BERAR.

From J. Cooper, Esq., Veterinary Superintendent, Hyderabad Assigned Districts, No. 179, dated 13th June 1889.

As previously stated in annual reports from this office, rinderpest (cattle plague) was accountable for the enormous losses in the provinces among oxen and buffaloes in 1886-87, the season of my arrival in Berar. The year 1887-88 was marked by an absence generally of fatal contagious fevers of the lower animals, and up to the present time anthrax has not been encountered here, nor have diseases of the so-called anthracoid type. From careful enquiries it has been ascertained from cultivators that epizootics of rinderpest occur in more or less definite cycles of time and commit frightful ravages among the horned stock of the province; but they also speak of other diseases of a fatal nature, which from their description may be, and probably are, anthrax. Alluding to the geographical distribution of the last-named disease, M. Chamberland, the learned Director of M. Pasteur's laboratory, in his "Charbonet Vaccination Charbonneuse," writes: "It (anthrax) is very widely spread, for in the whole world there is not, perhaps, a country where it does not exercise its ravages with more or less intensity." In his Note on Vaccination Charbonneuse Mr. Mukerji states: "Anthrax is fatal to almost all animals known." In making selections for experimental inoculation, however, it should be borne in mind that rats are infected with difficulty, and pigs, dogs, cats, and white rats have an immunity from the disease. The Algerian sheep is refractory to ordinary inoculations of the virus, but succumbs, according to Pasteur, when large quantities are injected into the veins. Experiment is required to determine whether the Indian sheep shares this idiosyncrasy. It is also worthy of note that Crookshank, in his recently-published manual of Bacteriology, states that the bacillus of anthrax is innocuous to adult asses and horses. Rinderpest.

Mr. Mukerji likewise points out the differential signs between anthrax and symptomatic charbon of the French, but the symptoms of anthrax are, in some cases, by no means clearly defined, and, besides symptomatic charbon, septicæmia may be confounded with it. To find the bacillus of anthrax it is necessary to make the microscopical examination immediately after death. If the *post-mortem* be delayed for some hours, one is exposed to the danger of meeting with putrefactive bacilli, and this may lead to error in diagnosis. The specific septic vibrione is not here alluded to; this micro-organism is motile and recognisable by its undulatory motion across the field of the microscope. It is, however, sometimes difficult to demonstrate. *Conf. with p. 1.*

The statement that animals dying of anthrax are invariably found bleeding from the anus and nostrils requires modification. This is the ordinary condition, *post-mortem*, of subjects of the disease; but I have seen two cases of death from inoculated anthrax in which there was no discharge of blood from the natural apertures.

SUMMARY.

The following summary has been kindly furnished by **Principal Veterinary Surgeon G. A. Oliphant** by a letter dated Simla, 19th September 1889.

I have the honour to forward a summarised statement of the opinions of Veterinary Officers who have had most experience as to the existence of true anthrax in India.

Bengal.

BENGAL.

Conf. with p. 11.

Veterinary Surgeon Cooper has not met with anthrax in the Berars, but the cultivators speak of disease other than rinderpest, which is probably anthrax. He is of opinion, with regard to the differences between anthrax and the sympathetic charbon of the French as detailed by Mr. Mukerji, that the symptoms of the anthrax are, in some cases, by no means clearly defined, and besides sympathetic charbon, septicœmia may be confounded with it. To find the bacillus of anthrax it is necessary to make the microscopical examination immediately after death. If the *post mortem* be delayed for several hours, putrefactive bacilli may be met with. The specific septic vibrione is not alluded to, this micro-organism being easily recognisable by its motion. The statement that animals dying of anthrax are invariably found bleeding at the nostrils and anus requires modification. This is the ordinary condition *post mortem*, but is not invariable.

Conf. with p. 2.

From experience at Umballa and Mustaphabad, extending over three years, Veterinary Surgeon Pease is of opinion that the disease known as Ludhiana disease or anthrax is true anthrax. It differs from charbon symptomatique in several particulars. In many cases death occurs without any manifestation, and, when œdema does occur, the swellings are different from those of charbon, are not so localised, not black on incision, and do not become painless, nor do phlyctinæ appear on them. They remain hot, tender, and somewhat tense, and are the result of a citron-coloured effusion into the subcutaneous connective tissue. Crepitation is invariably absent, forming a marked difference between disease and charbon. He does not remember ever having seen a case of charbon in the horse, and only once crepitation present in a case of anthrax, and that only immediately preceding death. He is of opinion that anthrax is not so fatal in places where it is enzootic. An organism is invariably found in the blood of animals dead from this disease, but whether it is the **Bacillus anthracis** he is unable to say, not having sufficient experience in the science of bacteriology to decide the question, and he is inclined to think that an opinion based on microscopical appearances without the tests laid down by Koch being carried out is likely to be misleading.

Cattle-disease known as splenic apoplexy is frequent and fatal, almost all animals attacked dying. Charbonous diseases—*galghotu*, gloss-anthrax, and black-quarter—are all very common. The last-named disease is distinctly charbonous, presenting all the distinctive characteristics, as crepitation, callosity, and dark colour when incised, and is not so fatal as splenic apoplexy, which is, probably, true anthrax.

He has not met with the disease in sheep.

Conf. with pp. 4—10.

Veterinary Surgeon Nunn differs with some of the differences between charbon symptomatique and splenic apoplexy, anthrax or charbon virulent, as detailed by Mr. Mukerji. No mention is made of the kidney, in which the **Bacillus anthracis** is much more readily found than in the heart—an important matter, as the kidney is the only organ from which fresh sections can be cut and stained at once satisfactorily

SUMMARY. Bengal.

without having to be hardened—a process entailing great delay. He presumes that the statement that charbon may arise spontaneously is a printer's error, as anyone with the slightest pretence to being abreast of current scientific literature must know that spontaneous generation was disproved, years ago, by Tindall and Darwin. Bleeding from the nose and anus is by no means an invariable *post-mortem* lesion. Although he (Mr. Nunn) has seen a number of cases of the disease known as anthrax in India, he has been unable to carry out investigations on proper scientific lines, but he has had considerable experience of this kind in Cape Colony, Natal, Zululand, and the Orange Free States, having been deputed specially to enquire into the Cape horse sickness.

The South African horse sickness, supposed to be anthrax, and very closely resembling it, proved to be a special form of fever of a malarial origin, which could not be propagated by inoculation. Anthrax is not, however, unknown in South Africa. He thinks that some cases in India supposed to be anthrax may be merely malarial fever, reliance having been principally placed on the discovery of bacilli in the blood, and it being impossible to say that an organism is the cause of a disease by the aid of vision alone. This can only be done by cultivation and inoculation. Inoculation experiments have been made in India, but it is not known whether they were made with proper antiseptic precautions. Cultivation experiments require great care and skill and expensive apparatus. He believes that equines in India are subject to several specific kinds of fever which have been classed as anthrax. The fact that animals have repeated attacks, sometimes at short intervals, is utterly irreconcilable with the disease affecting them being anthrax, as if once attacked they would be inoculated. Anthrax is also said to be on the increase, which may arise from the importation of Australian horses, and large admixture of English blood in country-breds, making them more susceptible to fever and malarious influences than the purely Indian horse.

Veterinary Surgeon Clayton is of opinion that true anthrax occurs in this country; in fact, it is the only form he has met with. His opinion is based on clinical facts, not having carried out any elaborate microscopical research.

Veterinary Surgeon Marriot has met with a number of cases of true anthrax at Sialkot, both amongst troop and private horses. He give the following instances:—

(*a*) A case in which a few anthrax bacilli were found in the blood on the second day of the attack and very numerous after death on the third day in the fluids of the body, coagulated lymph, spleen tissue, and petechial spots.

(*b*) A case in which the **Bacillus anthracis** was found in all the fluids of the body after death.

(*c*) Blood during life swarmed with rods **(Bacillus anthracis)** which decreased on the second day and disappeared on the third. This horse recovered.

(*d*) A charger which was destroyed. Before and after death the blood, stained with gentian violet, showed, under a $\frac{1}{12}$ oil immersion, numerous bacilli anthracis in process of fission.

He considers that the existence of true anthrax in Sialkot cannot be doubted.

Veterinary Surgeon R. W. Walker has only seen one mild outbreak at Mathra—14 cases and one death. He had not the necessary appliances to make a thorough investigation, but, from the clinical nature of the

SUMMARY. Bengal

cases and *post-mortem* appearances, he considers them to have been true anthrax.

Veterinary Surgeon Blenkinsop does not consider anthrax in its true form to be as prevalent in India as is generally supposed, but is confident that a disease due to a bacillus closely resembling the **Bacillus anthracis** does exist. He thinks that the disease usually called anthrax in this country, in the case of cattle and sheep, is charbon symptomatique, but that true anthrax, or a disease closely allied to it, affects these animals at times, without doubt. A large number of cases diagnosed as anthrax amongst horses he feels confident are remittent malarial fever. He saw a disease in sheep at Fort Chunar, in April 1888, resembling anthrax. He examined the blood with a $\frac{1}{6}$ inch objective, and found bacilli answering the description given by Klein and others of the **Bacillus anthracis.** He took some of the blood in a sealed tube to Allahabad and with it inoculated a pony, which died the second day afterwards with symptoms of anthrax, and bacilli were found in the blood just before death. In 1884 he saw some cattle dying of a disease resembling anthrax, but had no microscope and could not examine the blood. In the same year he saw symptomatic anthrax at Allahabad amongst transport cattle. In 1885 he saw two cases of supposed equine anthrax in Tirhoot. In both cases bacilli were found in the blood. In 1885-86-87 a disease occurred amongst grass-cutters' ponies at Dinapore, with bacilli in the blood. In 1888 he saw cattle in Mysore suffering from symptomatic anthrax, but had no microscope with which to examine the blood. A flow of blood-stained fluid from the mouth and anus of the carcass of an animal dead from any disease is not unusual if it has been allowed to remain exposed to a hot sun. He points out that bacilli resemble one another so closely that he is not justified in saying those seen by him were **Bacillus anthracis,** the miscroscope used by him being of low power and the methods of staining rough.

Veterinary Surgeon Cox states that charbon is of rare occurrence, if not altogether unknown, amongst horses in India, whereas anthrax is recognised by the existence of **Bacillus anthracis,** and is common amongst horses throughout the country. He has had extensive experience in England of charbon in all its forms, and can positively state that the difference between these diseases—in respect of symptoms, *post-mortem* and microscopical appearances—is most marked, and cannot understand that any doubt can exist on the point.

Veterinary Surgeon Barry considers Mr. Mukerji is wrong in stating that there are "two diseases entirely different in their origin and manifestation known as charbon," as there is only one, caused by the presence in the system of a special bacillus—*i.e.*, anthrax. The disease presents two forms—external or local, and internal or systemic. The former is frequently seen in cattle as black-quarter and in man as malignant pustule, and the latter in horses in India. In nearly all cases of anthrax he has seen there has been swelling of the glands of the neck, not merely sometimes as stated by Mr. Mukerji. He has frequently heard the well-known crepitating sound of emphysema in marked cases of anthrax, particularly in the emphysematous, not œdematous, swelling of the muscles of the neck and back. Only on a few occasions has he seen animals dying from anthrax bleeding a little from the nose, but never from the anus. He had opportunities of examining the blood (at Sialkot) of living and dead animals affected with the disease, and always found the **Bacillus anthracis,** observing it in the various stages of its development as long and short rods, containing spores, free spores,

and chains. There can be no doubt whatever, he thinks, that true anthrax exists in India, and that charbon is a mere local manifestation of the disease brought about by the same organism,—*viz.*, the **Bacillus anthracis.**

SUMMARY. Bengal.

Veterinary Surgeon Crow witnessed an outbreak of anthrax amongst the artillery horses at Bangalore in 1884. Microscopical examination of the blood left no doubt as to its being true anthrax. He is of opinion that cases of liver disease are sometimes registered as anthrax. True anthrax, like charbon in cattle, is fatal to every animal attacked. He does not believe anthrax is either contagious or infectious, but is introduced into the system by means of wet and foul grass, and he considers that the use of hay will do away with the disease altogether. He mentions the case of an old resident of Bangalore who kept valuable race-horses for 25 years, fed them on good hay, and never had a case of anthrax. Anthrax is also unknown in Bellary, where horses get hay nearly all the year round. He has no faith in Pasteur's inoculation, especially as the disease can be eradicated if the animals attacked are fed on hay. In 1864-65 he saw a number of cases of charbon in young cattle, all of which proved fatal. They were yearlings which had been well fed during the winter months, and had been turned out in the early spring on to wet, low-lying grass land. He has never seen cows or bullocks of three years old and upwards, nor horses or mules, affected (with charbon). The most prominent symptom is a large swelling in the hind or fore quarters, which crackles on pressure, and, when incised, is found to be quite black, as is also the blood throughout the body. The preventive measures suggested by him are the use of dry food, housing at night, and abstinence from grazing until the sun is well up. He thinks it conclusive that charbon and anthrax are both introduced into the system through the grass. He has never seen charbon in cattle or horses in India. The last case of icterus (liver affection) he treated was in Rawalpindi. The horse had a temperature of 106°, and there was an amber-coloured discharge from its nostrils : it recovered under treatment. It had a record of having previously had anthrax.

Conf. with p. 4.

Veterinary Surgeon Joslen, during his service in India, has met with true anthrax—*i.e.*, anthrax fever without any local manifestations, except petechial spots on the conjunctival membrane—in every station in which he has served.

Bombay.

Bombay.

Inspecting Veterinary Surgeon Anderson considers that true anthrax occurs in India both amongst cattle and horses.

Veterinary Surgeon Steel has no doubt the true anthrax exists in Bombay, though he has no evidence to establish the fact.

Veterinary Surgeon Meredith, assuming that Mr. Mukerji has established the difference between charbon and true anthrax, has no doubt about the existence in India of true anthrax as exemplified by the outbreak in Mhow in 1888.

Conf. with p. 2.

Madras and Burma.

Madras.

Inspecting Veterinary Surgeon Shaw states that Mr. Mukerji's opinions are not original, as they appeared in the Veterinary Journal for 1885, and thinks that too much reliance should not be placed on the statements, as far as India is concerned, where true anthrax is always present.

Veterinary Surgeon Taylor's experience is limited to ten cases which occurred amongst troop horses at Secunderabad. In his opinion these were all cases of true anthrax. The majority showed most marked

SUMMARY. Madras.

lesions in the abdominal organs; only two or three presented external swellings, and these were merely œdematous swellings of the throat and not crepitating swellings of the loins and quarters so characteristic of charbon symptomatique. He considers that Mr. Mukerji's statement regarding the flux of blood from the nose and anus is not correct. He has never seen anything more than a straw-coloured discharge from the nostrils.

Veterinary Surgeon Waddell is satisfied that true anthrax exists in India to a very considerable extent. He has seen the disease in every station at which he has been quartered—Bangalore, Secunderabad, and St. Thomas' Mount. He is of opinion that the charbon, splenic apoplexy, and Ludhiana disease are identical with anthrax, and the slight differences noticeable in the bacilli are due more to the class and condition of the animals affected than to any real difference in the nature of the disease. He has constantly examined microscopically the blood of horses affected with anthrax, and has always found the same characteristics, whether the animals died of the thoracic or abdominal type of the malady. He also examined the blood of a swan which died, with many others, from anthrax, and was unable to find any difference in the bacilli, though the blood corpuscles were naturally different. Anthrax blood is always very dark in colour, and extravasation into the abdominal cavity occurs in many cases to a very considerable extent. The spleen is invariably enlarged, dark in colour, and contains more bacilli than any of the other viscera. Animals dying from anthrax are not invariably found bleeding from the nose and anus. Mr. Waddell has seen only the characteristic amber-coloured fluid escape in a large percentage of cases.

Anthrax has by all investigators been divided into different forms. The divisions generally accepted are "general" and "localised," both of which forms Veterinary Surgeon W. J. Adams considers true anthrax, and both of which, he thinks, exist extensively in India.

Veterinary Surgeon Durant has seen anthrax fever on several occasions in India, with symptoms varying. Having perused Mr. Mukerji's notes, he thinks he has seen both forms of the disease charbon, at Kamptee in 1878, and on the Government Farm at Khandeish in 1879. The disease, as there seen, attacked all classes of animals, and amongst them (at Kamptee) fowls and turkeys. In 1888 he had several cases of what he considered true anthrax amongst horses of the 14th Hussars at Secunderabad. Bacilli were found in blood exposed to the air, but none in blood taken during life. The duration of the disease was from a few hours to three or four days. Since coming to Bangalore he has seen and treated several cases of what he considers true anthrax in horses. He has examined blood microscopically, assisted by Dr. Kelly, and found long narrow rods and chains. He differs from Mr. Mukerji as to the duration of the disease. Some cases die in a few hours; others last several days. The disease is, doubtless, propagated from germs brought in the grass-cutters' grass. He expects to see it after light showers and it disappears after heavy rain. As to its contagious nature, he has never seen it attack two horses standing together. Nor has he recognised the two diseases as distinct, but, on the contrary, has always considered them the same, modified by temperature and local influences.

Veterinary Surgeon Symonds states that anthrax exists in Southern India, and during the eight years he has been in Madras, he has yearly seen the disease in its most virulent form both in horses and cattle. In 1884 he visited (in company with Mr. Mills, Inspector of Cattle Diseases) several villages in the Chingleput district, to enquire into an outbreak

SUMMARY. Madras.

of disease. He saw a large number of animals dying and dead, and made many *post-mortem* examinations. In every case the **Bacillus anthracis** was found in the blood taken from dead animals, but not in that taken from the living. Blood from the spleen and liver was carefully collected, and guinea-pigs were inoculated with it. Every one of them died in from two to four days, showing all the characteristics of true anthrax, and microscopically the **Bacillus anthracis.** He never heard of the disease charbon symptomatique affecting cattle in the Madras Presidency. He has constantly seen œdematous swelling on the throat and other parts of the bodies of animals suffering from charbon virulent, but could not detect crepitation nor discover a bacterium or bacillus in the exuded fluid.

Veterinary Surgeon Butler has had the opportunity of seeing only one outbreak of disease of an anthracoid nature in which he was able to make microscopical examination of the blood, and on that bases his deductions. In January of the present year three horses died at St. Thomas' Mount of a disease which he decided to be anthrax. He finds the following points of resemblance and difference between what was observed in this outbreak and in Mr. Mukerji's experiments :—

(*a*) One case lived more than 36 hours after admission; the other two died within 24 hours. Allowing for the incubative period, this would bring them to more than 36 hours.

(*b*) A bacillus was found in each case and every specimen examined, but the blood was invariably taken from an incision into a vessel.

(*c*) In two cases only was swelling of the maxillary region present, and there was no crepitation of the œdematous area.

(*d*) Spore formation was not observed in any of the specimens, which were all examined as soon as taken from the body, nor was the chain formation seen.

(*e*) The organism was a bacillus, long and narrow, with rectangular ends.

(*f*) There was no bleeding at either anus or nostrils.

It will be seen by the above that his observations agree with those of Mr. Mukerji in the following points :—

1. Duration of the disease.
2. Existence of a bacillus.
3. Occasional swelling of the sub-maxillary regions.
4. Absence of crepitation over œdematous area.
5. Absence of spore formation in the specimens.

The following points are at variance :—

6. Chain formation of a bacilli was not observed.
7. Dying animals bled neither at the nostrils nor anus.

Mr, Butler is unable to say whether the organism was present in every tissue of the body, but it was present in every specimen examined. He concludes that the disease was anthrax proper, but does not come to a definite conclusion, pending further opportunity of making microscopic investigation

Veterinary Surgeon Gladstone has had two cases of what he considers true anthrax lately in Mandalay. The symptoms were high fever, large firm swelling of the throat, yellowish discharge from the nostrils, sometimes mixed with blood, and great difficulty in breathing. Microscope examination revealed characteristic straight rods of the **Bacillus**

SUMMARY. Madras.

anthracis with straight cut ends. This officer has no doubt that true anthrax does exist in India, as he had many cases about eight years ago in Belgaum similar in every respect to those now recorded. Disease of an anthracoid nature exists in the Madras Presidency, notably in Tanjore and Chingleput, but Veterinary Surgeon Hazleton has not met with a case during his tours of inspection, the reason of his not doing so being that the disease in all its forms is so rapidly fatal that an outbreak has generally subsided before reports are received. He has not the slightest doubt that anthrax exists in many parts of Southern India amongst cattle and sheep. His experience of the disease amongst army horses at Secunderabad and St. Thomas' Mount has been large. The latter place is in the Chingleput district, from whence frequent reports of anthrax amongst cattle and sheep are received from the Stock Inspectors. These reports refer to all cases of an anthracoid nature, and include malignant sore-throat and quarter-ill or black-quarter, as well as true anthrax. During the quarter ending 31st March 1889, 4,341 deaths of cattle and 1,147 deaths of sheep were reported from the whole presidency. In the year 1887-88 one Stock Inspector reported a considerable mortality amongst pigs and dogs having taken place at a village in the Vellore district after they had been feeding on carcasses of cattle which had died from anthrax. He holds firmly to the opinion that anthrax amongst army horses is due to contamination, by infected cattle, of the lands from which the grass supply is obtained.

Inspecting Veterinary Surgeon Evans, who was the first to discover the organism known as the **Bacillus anthracis** in the blood of affected horses in India, and to settle the nature of the malady, states that, while he was in India, anthrax existed and caused the death of a number of horses; but he was convinced that many cases reported as anthrax were not really so, but cases of what Koch calls malignant œdema and Pasteur septicœmia, not the same disease as is commonly known as septicœmia in England and Germany. The organisms of anthrax and malignant œdema are widely different under a good microscope. In both cases the examination should be made in fresh blood. Malignant œdema was a term used in India, as well as anthrax, before the organism of either was determined: afterwards the term of anthrax was alone officially used. The symptoms of the two are so much alike that the microscope is necessary to determine, by finding the organism, which the case under observation is.

Conf. with p. 10.

Veterinary Surgeon Frost states that true anthrax prevails in Burma, but not to an alarming extent. His investigations have been limited to search for the anthrax bacillus in the blood and tumours or œdematous swellings, together with *post-mortem* examinations, and from these investigations he is convinced that true anthrax does prevail in Lower Burma.

Mr. G. A. Oliphant, Principal Veterinary Surgeon in India, concludes his summary of the evidence of Veterinary Officers in the following paragraphs:—

2. The general conclusion to be arrived at from the foregoing summary of opinions of Veterinary Officers throughout India can only be that true anthrax does exist in India, both amongst army horses and cattle, and there is but little doubt that ordinary charbon also exists to a considerable extent amongst cattle.

3. The more refined methods of investigation and cultivation of the bacillus or organism causing anthrax and inoculation with it have not been carried out, for the simple reason that the means to do so have not

been at hand. Several attempts have been made to send diseased blood to Calcutta for this purpose, but they have proved futile owing to changes taking place in it. The **Bacillus anthracis** has been observed in the blood frequently under the microscope, and inoculations with fresh blood have reproduced the disease with all its marked symptoms and *post-mortem* appearances. Moreover, both symptoms and *post-mortem* appearances of true anthrax differ so considerably from ordinary charbon that to the expert there can be no possibility of making a mistake between them. However, it is extremely probable, especially in large outbreaks or under circumstances where microscopical examination of the blood has not been undertaken, that cases of fever of a malarious type have been classed as anthrax.

SUMMARY.

True Anthrax *versus* Ordinary Charbon.

4. Mr. Mukerji's notes contain nothing of an original character or that is not already well known to the Veterinary profession, and some of his statements, if not absolutely incorrect, do not, at any rate, tally with the results of experience gained in this country. For instance, the assertion that animals dying of anthrax are invariably found bleeding from the nostrils and anus is not only not correct, but, if left uncontradicted, might lead to serious loss by favouring the spread of the disease, owing to cases, in which this appearance was absent, being overlooked.

5. True anthrax is pretty general throughout India, the stations from which it is notably absent, or nearly absent, being those in which, for a greater portion of the year, horses are fed upon hay or dry grass. Nowgong and Saugor are two of these.

6. The disease is certainly not on the increase in the army, and, under the regulations which have been enforced during the past few years, no very excessive mortality has taken place at any station, such as occurred at Rawalpindi, for instance, about the year 1878, when one battery lost 40 per cent. of its horses.

7. During the past four years anthrax has been reported from the following stations in Bengal :—

Umballa.	Rawalpindi.	Meerut.	Jullundur.
Jhelum.	Dinapore.	Calcutta.	Cambellpore.
Kalabagh.	Peshawar.	Muthra.	Chunar.
Lucknow.	Saugor.	Gharial.	Manipur.
Sialkot.	Multan.	Nowshera.	Silchar.
Bareilly.	Meean Meer.	Jubbulpore.	Shillong.
Ferozepore.	Barrackpore.	Allahabad.	Edwardesabad.
		Fyzabad.	

It has also been prevalent throughout Burma. and occurred in the Bombay and Madras Presidencies.

8. This, I think, is conclusive proof of the wideness of its extent.

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FODDER.

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SILAGE-MAKING IN INDIA.

Note by DR. J. W. LEATHER, *Agricultural Chemist to the Government of India.*

1. During the last ten years a large number of experiments on Ensilage have been made in the different Presidencies and Provinces of India. At the Military Grass Farm, Allahabad, and at Cawnpur, Nagpur, and Khandesh Experimental Farms, the process has been systematically tried, whilst in Madras a large number of Silos were filled by District and Forest Officers in 1886.

For the moment it may be sufficient to say that on the whole the process has been fairly successful, up to a certain point. The details of the experiments and the causes of loss that have attended them will be considered later on.

PART I.

The Process in Europe.

2. For some years the subject has been discussed by agriculturists in Europe. The weather during the summer of some European countries, especially that of England, is so uncertain that it frequently happens that the grass, after being cut and before it is made into hay, is entirely spoiled. The process of Ensilage was therefore recommended as a substitute for hay-making. Considered as such, it may be said to be a complete success in Europe, since, although, as will be seen presently, the process subjects the grass to greater loss than if it had been made into hay, it is nevertheless one which may be carried out in the worst weather, and is, at such times, of very great value.

Chemical Changes.

3. It may be as well to consider here the changes which take place during Hay-making and during the process of Ensilage.

Hay-making.

a. Hay-making.—This is a simple drying process in the first place. The grass is not permitted to become quite dry; a certain small amount of moisture is allowed to remain, in order that a slight fermentation in the stack may result. In the case of an experiment made at the Farm of the Royal Agricultural Society of England in 1886,* the grass used for

Experiments at Farm of R. A. S. F

* *Vide* R. A. S. E. Journal, 1887.

FODDER.	Silage-making

Losses.

a stack of hay was weighed and analysed and the hay was afterwards likewise weighed and analysed. Thus, not only was the total loss in weight determined, but likewise what the loss consisted of. The grass used weighed 34,442lb; the hay 11,152lb; the loss 23,290lb, or 67·62 per cent. Of this, 64·57 per cent. was water. The remainder was almost entirely due to loss of a part of the digestible fibre,—woody fibre and carbo-hydrates present in the grass. The amount of these together, in the fresh grass, was 8,668lb and in the hay 7,670lb; the loss was therefore 998lb, or 11·5 per cent. Of the albuminoids present in the grass there was no loss, but a considerable proportion of the Insoluble albuminoids became Soluble; of the total Nitrogen originally present there was a slight loss—the grass contained 160lb Nitrogen, whilst the hay contained 150lb.

Loss of Water.

Loss of Carbo-hydrates.

Loss of Albuminoids and Nitrogen.

During the process of hay-making, therefore, the loss of food material is but very slight, and what *is* lost consists principally of carbonaceous principles.

Ensilage.

b. Ensilage.—It is undesirable to attempt any lengthy essay on this subject. Briefly it may be stated that when fresh gras is kept in a chamber, from which the air is entirely excluded and the temperature allowed to rise to 80-100° F., fermentation ensues with the formation of several acids, acetic and lactic acid, etc. If, on the other hand, the atmosphere be more or less admitted, moulds form and oxidation and putrefaction take place.

Experiments at Farm of R. A. S. E.

4. Turning again to the experiments of the Royal Agricultural Society of England, for information as to the changes which occur in the process of ensilage, we find that a series of experiments was carried out during the years 1884-85, 1885-86, and 1886-87. Altogether 8 silos were filled, 5 of which contained grass, 2 clover, and 1 green oats. The silos were very well built, being on three sides of brick-work above ground and lined with cement. The front end was at first made of boards placed in position as the grass was filled in. The fodder was covered with boards, on which stones of a weight of about 100lb. per square foot were placed. The total losses sustained with these silos was in 1884-1885: with grass 11·5 and 22 per cent., with clover 21 and 8 per cent., and with green oats 15 per cent. In 1885 the front ends of the silos were also bricked up and cemented and the losses then amounted to 5·5, 7·2, and 12·5 per cent. respectively; grass being the material "pitted." The amount of mouldy silage was also perceptibly reduced. In the case of the experiment made in 1886-87 the grass and silage were very carefully analysed and weighed, and the results showed, as in the case of the hay, which of the food constituents were affected and to what extent. The grass used weighed 32,780lb; the silage weighed 30,389lb; and the losses amounted to 7·29 per cent. The water in the grass—23,108lb, that in the silage 22,035lb, the loss 1,073lb. There was no opportunity for drainage, and therefore this loss is attributable to evaporation. It is equal to 3·27 per cent. on the weight of fresh grass, and the difference between this and the total loss of 7·29 or 4·02 represents the loss of food material.

Materials used.

Losses.

Total loss.

Loss of Water.

Loss of Carbo-hydrates.

The digestible fibre, the woody fibre and the carbo-hydrates in the grass weighed together 8,213lb; that in the silage 6,989lb, and the loss 1,224lb. But some acetic and lactic acids were formed, amounting together to 215lb. Allowing these to have the same value on food as the carbo-hydrates, the net loss of carbonaceous food was 1,009lb or 12·3 per 100 parts of carbonaceous principle. Of the total Nitrogen in the grass employed there was no loss; 151lb Nitrogen was found in the grass and 155lb Nitrogen in the silage.* There was, however, a loss

Loss of Nitrogen and Albuminoids.

* The slight difference between these two amounts is owing to unavoidable error of experiment.

of albuminoids, a portion of these being converted into non-albuminoid substance. The albuminoids in the grass amounted to 780lb, in the silage to only 449lb.

Quality of Silage.

5. Of the quality of the silage, it will be sufficient to say that the silage was employed in a comparative feeding experiment on bullocks; one lot of beasts being fed on cotton seed-cake, maize and silage, the other lot on cotton seed-cake, maize and hay, the result of which was to show the feeding value of silage to be slightly superior to hay.

Reason for these details.

6. I go into particulars of these experiments regarding the losses sustained during hay and silage making in order to illustrate what *may* be done under exceptionally favourable conditions; the silo was what may be termed perfect, and the grass was filled in under experienced supervision. Under these circumstances the total loss was small, but the loss of food material, especially in the case of the albuminoids, was by no means so. The process of ensilage, then, cannot be described as an economical one in comparison to hay, and is only to be recommended for use when hay cannot be made. Moreover, it is more expensive, for it entails greater labour in haulage. When silage has to be made without a cemented silo the loss is naturally very much greater. In one case, which came under the writer's observation, the loss amounted to no less than 50 per cent.

Conditions under which Ensilage may be recommended.

"Sweet" and "Sour" Silage.

7. There is another point to which reference must be made. The rate at which the material should be pitted has been the subject of some little discussion in Europe. It has been maintained that if the temperature of the mass can be raised rapidly to some 150° F., the ferments will be destroyed, the fodder will suffer only a small loss, its odour will be pleasant, and instead of being "acid" it will be "sweet." The advocates of this Ensilage system recommend that the material to be "pitted" should be put into the silo in portions, allowing an interval of a day or two to elapse between the successive additions; in consequence the temperature of the mass rises considerably higher than if the silo be all charged at one time. This process is thus thought to stop fermentation, and produce "sweet" silage. Whether such silage can in practice be prepared, is, however, very problematical. Many samples of so-called "sweet" silage have come under the writer's notice in England, but none of them have been either "sweet" or free from smell. Moreover, so far as chemical analyses show, these samples contained quite as much acidity as those which had been made by filling all the material into the silo as quickly as possible, instead of waiting to allow the temperature to rise. In the majority of instances, too, the temperature had been raised so high as to destroy the sugar, and the samples had accordingly the odour of "caramel" (burnt sugar).

Part 2.

Indian Experiments.

8. Considering now the experiments which have been made in India, we find that, with few exceptions, the silos have been simply rectangular or circular pits in the ground, the sides of which have been in some cases plastered with cow-dung. The sizes have varied very considerably—from 10×8×5 feet deep (one of the smallest), to 30×12×6 feet deep, the dimensions of some of the largest.

Description of Silos.

A few of them have been lined with brick-work. At Cawnpore two masonry silos were made in 1883 and a third added the following year. At Khandesh a circular and brick-lined silo was built in 1889, one half being below ground; and at Nagpur in 1890 two brick-lined silos of 450 cubic feet and 1,522 cubic feet capacity, respectively, were made. The remainder, including more than 100 at Allahabad and upwards of 50 in the Madras Presidency, have been plain holes in the ground.

FODDER. | Silage-making

Covering employed.

9. These silos have usually been simply covered over with the earth which had been excavated. In some cases matting was first placed on the fodder.

Materials pitted.

10. The list of materials "pitted" includes grass, *juar* stalks, green *juar*, green maize, **Sorghum saccharatum**, guinea-grass, paddy stalks, prickly pear. The grass has usually been put in whole, so also the guinea-grass; but the other materials have sometimes been chopped up before "pitting."

Time occupied in filling Silos.

11. The time occupied in filling the materials into the silos has varied also very greatly. The slow-filling process has had a very exhaustive trial. At Nagpur it was tried in 1886 with *juar* and with **Sorghum**, and in 1889 with *juar* and guinea-grass. In the case of the first of these 9 tons *juar* was pitted during 4 days, and the silo was opened at the end of $5\frac{3}{4}$ months. It appears to have been a great success, for Mr. Fuller, in his report on the Nagpur farm, speaks of it as being good and sweet and possessing no unpleasant odour. On the other hand, the **Sorghum**, which was pitted during 9 days the same year, was rotten when opened at the end of $6\frac{3}{4}$ months, the reason stated being that it was cut over-ripe. The next year both guinea-grass and *juar* were pitted slowly, and when opened it was found to be in fairly good condition. Again, in 1889 and 1890 the same materials were pitted on the "slow" filling system and the grass seems to have been of fairly good quality. In only one case, however,—namely, the *juar* of 1886,—could the silage be called sweet and free from smell. In the other cases the quality appears to have been similar to that made by the "rapid" filling process. At Allahabad in 1885-86 the question was taken up very systematically: the grass was filled into different silos in 2, 3, 4, 5, 6, 7, and 8 days respectively, and the result was in favour of rapid filling. In the case of all other reports which have come under the writer's notice, there is nothing to show that the "slow" filling process has any advantage over the "rapid" one. On the other hand, there are certain disadvantages, one being that in order to carry it out the material must be covered and uncovered again for each filling, which means extra labour; and a second is that when silage is made during the monsoon, rain collects in the half-filled silo. As much as 2 feet of water was found in one of the pits at Allahabad whilst it was being filled on this system.

Quality of the Silage.

12. The quality of the silage made has on the whole been decidedly good. At Allahabad it has been used now on a large scale for bullocks ever since it was first introduced, more than 100 silos being filled annually and from 20,000 to 30,000 maunds of silage made. At this farm, too, it is considered to be financially economical. Much the same may be aid of silage made at Khandesh, Nagpur, Cawnpore, and Madras. Sometimes it has been a complete failure, but there has generally been some simple explanation of this.

Prickly pear.

13. The only material which has been fairly tried and one which has proved a complete failure is the "prickly pear." It was employed in many of the Madras silos and was found invariably to be simply a mass of fibre on opening the silo. It is, however, an entirely different material from the grasses generally used.

Losses sustained.

14. It may now be desirable to consider the losses which have been sustained. In many cases this point has been entirely overlooked, and if the grass or other fodder has been weighed when going into the silo, no record of the silage made has been kept. Sufficient cases are, however, on record, in which the necessary weighments have been made, to enable us to form an opinion as to the losses these materials are subject to, when pitted in earthen silos. At Nagpur the loss has varied from 11 per cent. to 64 per cent.; at Khandesh it has varied from 28 per cent. to 71 per

Nagpur. Khandesh.

cent. At Allahabad in 1892-93, 33,652 maunds grass made 21,781 maunds silages, which is equivalent to loss of 35 per cent. This result is perhaps the most trustworthy of any, since ensilage at Allahabad has for some years been considered an economical method of storing fodder for draught bullocks, and the above figures are, moreover, the totals of a number of silos. The losses sustained, then, in the Indian experiments have been with few exceptions considerable. Allahabad.

15. Regarding the chemical composition and the losses of the individual constituents nothing is known, no analysis having been made. Chemical Composition.

Part 3.

16. I have gone into the results of the experiments on ensilage in India somewhat fully, because it has been recommended as a suitable method of preserving fodder which the Indian cultivators might adopt. Bearing in mind the fact that it pays the Military authorities at Allahabad to use the process regularly, it might be assumed that it should therefore pay the general cultivator. In an early paragraph I have given the evidence obtained at the Experimental Farm of the Royal Agricultural Society of England on the comparative value of hay-making and ensilage; it has been there shown that the losses sustained in the latter process, even under exceptionally favourable conditions, are materially greater than when hay is made. The total loss in ensilage (page 2) was in these experiments, however, only 7 per cent. In India the losses have been much greater. It is, moreover, doubtful whether they can be avoided under existing circumstances. In the case of an earthen silo the drainage must no doubt be considerable. Some idea of this is obtained if a silo be made above-ground. It will then be seen that the juices simply run out during the early periods. And, judging by what appears in the reports, there is considerable *mouldy* silage formed, owing no doubt to the impossibility of preventing admission of air. The earth covering the pits cracks, and the cracks require to be constantly filled up. Lastly, it would appear to be somewhat difficult to keep out the rain water. Deductions made from available information. It pays the Military authorities; will it pay the ryot? Cause of mouldy Silage.

17. But, although the loss at Allahabad is so great, the reason the Commissariat authorities give for making silage is a perfectly sound one. The grasses come to flower during the rains, in August, and hay cannot be made. It is therefore more economical to make silage of the first crop of grass; the second cutting is made into hay after the rains. It is therefore economical to store the early grass as silage (in those districts which are too wet to admit of hay-making), and ensilage is therefore a process by which fodder may be stored for many months and it may be regarded as a means of providing for scarcity of fodder in dry years. Reason why Silage is made at Allahabad.

18. Looking at the subject from the cultivator's standpoint we must now consider what the process would cost him. I am inclined to think that it is preferable to endeavour to estimate the amount of time rather than to put it in terms of rupees. And I do so for two reasons,—firstly, because a cultivator does not usually pay anything at all for fodder for his cattle; and secondly, because the cost of a cultivator's time must naturally depend on what other work demands his attention at the particular time when silage has to be made. Subject considered from cultivator's standpoint.

19. A bullock in full work will require 30lb of silage per day, and consequently a pair will require 60lb. Bearing in mind the results of silage-making at Allahabad, we may take the loss at 33 per cent., or $\frac{1}{3}$ of the weight of grass employed, and therefore for 60lb of silage 90lb of grass would be required. Assuming further that working cattle require an amount of silage equivalent to the *bhusa* or *juar* stalks usually given, a Size of Silo and its cost.

supply of silage for six months would require 200 maunds of grass to be "pitted." A silo large enough to hold that quantity would have to be about 10′ × 10′ × 5′ deep, or 500 cubic feet capacity. To make such a silo would certainly not take long, say a couple of days; and with a bamboo and grass cover over it, such as cultivators can so readily construct, it might be made at any period of the year when they had the time to spare.

Materials for Silage.

20. In the next place, what are the materials which he would profitably convert into silage? The food of his cattle consists of the stalks of the various cereal crops which are grown for grain: wheat, barley, rice, *juar* and *bajra* stalks fairly comprise the list. In some places small quantities of *juar* are grown for fodder, but this is an exceptional practice. In any case there would be no advantage in putting any of these fodders into a silo; they all come to hand at a period of the year when they may be stacked above-ground and are indeed better so preserved. The only material which has to be considered in relation to the process of ensilage is grass. In paragraph 17 I have explained that grass must be cut in the monsoon.

Cost of cutting grass.

21. The remaining item is the expenditure of time required for cutting the grass. At Allahabad the grass-cutters are paid by the maund of grass cut. In 1883, 9 pie per maund was the rate, but in 1886 the pay was reduced to 6 pie per maund. It was found that they could cut some 16 maunds per day, and having regard to the conditions of payment, it will be a fair estimate if we assume that a cultivator can cut that quantity. He would require, therefore, more than 16 days to cut the 200 maunds of grass. But whilst the silo may possibly be made at any time of the year most convenient to the cultivator, the grass would require to be cut in the monsoon,—that is, at one of the busiest times of the year. For a cultivator to find more than two weeks for grass-cutting at this season seems out of the question, and it is probable that this is the reason why a process for preserving grass, which is found economical at Allahabad, and has been proved successful at so many other places in India, has not been generally taken up by the cultivator.

Conclusion.

22. At paragraph 224 of Dr. Voelcker's Report on the Improvement of Indian Agriculture a statement of the comparative cost of cutting grass for ensilage and hay is given. The figures are taken from the Report of the Allahabad Farm, and they show clearly how expensive is the making of silage in India; and in paragraph 219 of his report Dr. Voelcker compares the cost of cutting grass in England and in India, and it is clear that this is where the difficulty lies. It is not so much that silage is unsuitable as that it costs a cultivator too much time to cut the grass.* The same applies to the matter of hay-making. What seems to be required is that the cultivator should learn to use the scythe. He would then be able to cut sufficient grass for a whole year for his bullocks in two or three days. There is quite enough evidence at hand to show that they can be taught to use the scythe, and it might with advantage be introduced into the Agricultural Schools.

J. WALTER LEATHER,

Agricultural Chemist to the Govt. of India.

An equally important difficulty lies in the want of a sufficient supply of grass, at least in most districts of India.—*Ed.*

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THE

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MANURE:

FARM-YARD.

[*Dictionary of Economic Products of India, Vol. V.*, M, 238; *also The Agricultural Ledger*, No. 20 of 1893 and No. 7 of 1894.]

Note on the Value of Indian Cattle Dung by DR. J. W. LEATHER, *Agricultural Chemist to the Government of India.*

Value of manures.

1. The value of cattle dung as manure has been tested at different Experimental Farms on a variety of crops, and it has been usual to appraise its value, not only by any increase in outturn of those crops, which the experiments may have shown to be due to it, but also to convert these results into money values, deducting from the value of the increased outturn, the estimated money value of the dung. In addition to cattle dung, various other manures have been employed on similar adjoining plots of land, and their effect registered in a similar manner. Among the latter may be named crude saltpetre, bone meal, and a green crop ploughed in. In the present note, I propose to review the effect of manuring land with cattle dung, and to set out what its value is, as deduced from certain experiments which have been made at the Experimental Farms situated at Cawnpur in the North-Western Provinces and Oudh, at Nagpur in the Central Provinces, and at Dumraon and Burdwan in Bengal.

The experiments at other farms have not yielded sufficiently accurate results to admit of their inclusion in this note.

Determination of value.

2. In determining a value for cattle dung one of three methods might be adopted: its effect may be compared (1) with the plots to which no manure has been applied, (2) with that of other manures, or (3) the results may be reduced to money values. Against the last method there is much to be said, for in the first place money values of commodities vary considerably from year to year, and from locality to locality, and any valuation thus made is correct only for one set of prices, which may require altering tomorrow, whilst in the second place it is difficult to know how to place a money value on cattle dung at all, for the demand probably varies in every village. As to the second method, a comparative value could only be made through the medium of the outturn of different crops. But this method might be adopted, were it not for the fact that neither

MANURE: Farm-yard. **Note on the value of**

in the case of saltpetre nor in that of bone meal have these manures been applied in quantities bearing any relation to their chemical composition or to that of cattle dung. In the case of ploughing in a green crop the case is different, and I add a comparison of the effect of this method of manuring with that of dung.

For the primary determination of the value of cattle dung I adopt the first method, namely, that of comparing the amount of produce obtained from certain plots of land, some of which have been manured with cattle dung, for a series of years, whilst on certain other adjacent plots no manure has been applied.

Reliability of statistics.

3. The first consideration is as to which of many experiments, made at the above-named farms, are sufficiently reliable, to permit of their being used for the purpose in view, and here the fact is at once apparent that the results of experiments do not possess anything approaching the regularity which has been attained at such experimental stations as those at Rothamsted or Woburn in England. Possibly constant change in the management has had something to do with this, but it is more than probable that the extreme nature of the seasons experienced in India is accountable for much of the irregularity in the outturns. An examination of the results shows that none of the series of experiments made admit of simple averages being struck, and that a much more detailed examination is necessary. Consequently no simple value for cattle dung, even in terms of grain, can be arrived at. It will be only possible to exhibit its value within certain limits. Another point must be noticed in preface, namely, that only in one series of experiments (Nagpur) was the manurial effect of dung tested on dry land for a cold-weather crop. In the case of all the experiments at Cawnpur, Dumraon, and Burdwan, the cold-weather crops were artificially irrigated.

Experiments made.

4. The experiments which I propose to examine are (1) two series made at Cawnpur on the effect of manuring wheat and maize for thirteen years, of which twelve years' results are available; (2) a series of plots at Dumraon on which wheat has been grown for six years; (3) one series of plots at Burdwan on which rice has been grown for four years; (4) two series of plots at Nagpur on which wheat has been grown *without* irrigation for ten years (of which nine years' results are available) and for six years respectively; and one series of plots at Nagpur on which wheat has been grown for four years *with* irrigation, of which three years' results are available. I shall consider the experiments in the above order, because the first three named farms are all situated within the Gangetic plain, *i.e.*, on alluvial soil, whereas Nagpur is situated on the "black cotton soil" of Central India.

CAWNPUR EXPERIMENTS.

5. *The Cawnpur Experiments.*—Four series of plots have been set apart at Cawnpur for the purpose of testing different manures, and mixtures of manures, on the wheat and maize crops, since 1881. On one of these series, called the "Standard," wheat has been grown every year; each plot is manured differently, but the same manure, in the same quantity, is applied to the same plot each year, No. 1 plot receiving a dressing of 240 lb of crude saltpetre each year, No. 2, 132 cwt. of cattle dung each year, and so on through the series. Another series of similar plots is set apart for the continuous growth of maize. This series includes the same number of plots and is called the "Standard" maize series; they are manured with the same description of materials, applied in like quantity, as the "Standard" wheat series. There are in addition two other series of plots called the "Duplicate," also manured annually with the same description of materials and in like quantity as the two "Stand-

ard" Series. On these two series, however, wheat and maize are grown alternately, maize occupying the land of one series in the monsoon, whilst wheat occupies the other series of plots in the following cold weather. Consequently, after the maize crop has been harvested from one "Duplicate" series, the land lies fallow for nearly fifteen months, after which wheat is put into this series; whilst in the case of the other "Duplicate" series maize is put into it three months after the wheat has been harvested. These two "Duplicate" series, therefore, not only bear alternate crops of wheat and maize, but enjoy alternately fallows of three months and fifteen months respectively. The manuring, as has already been explained, is the same for all four series *alike*. Whenever, therefore, maize is grown on either of these "Duplicate" series of plots, it is sown after a three months' fallow; whilst whenever wheat is sown on them, it is after a period of fifteen months' fallow. It is interesting to notice, in passing, the relative effects of this difference in length of fallow, and, as will be seen from the subjoined statements of the outturns of grain on the three plots mentioned, whenever differences occur between the outturn of a plot in the "Standard" series, and of its fallow in the "Duplicate" series, there is *generally* (though not always) an *increase* in the case of wheat, whilst conversely there is *usually* a decrease in the case of maize. A similar difference appears in the case of other plots of these four series which are not named in the statement. This effect of fallow is what one would expect, and coincides with the teachings of European experience.

CAWNPUR EXPERIMENTS.

6. As already mentioned in paragraph 3, it is not sufficient in examining the results of these experiments to strike a simple average, for the outturns vary in individual years too much. Where, in any series of figures, the individual members vary considerably from the arithmetical mean of the series, it appears to me to be a mistake to strike that mean as representing the average of the whole; this may only fairly be done when no great differences exist between different members of the "series." It is necessary, therefore, to examine the results in greater detail.

Averages not reliable.

7. The plots which I have selected for consideration are, in the case of wheat, two plots which have been left unmanured from the commencement, one in the "Standard," the other in the "Duplicate" series; two plots, one, the "Standard," the other in the "Duplicate," series, on which cattle dung at a rate of 132 cwt. per acre has been applied annually; and two plots likewise in the "Standard" and "Duplicate" series respectively, on which 132 cwt. of cattle dung plus 240 lb of gypsum per acre has been applied annually. These latter I include because in the first place the cattle dung employed probably contained an amount of lime equal to that in the quantity of gypsum employed, and therefore it has not been a case where one plot received no lime, whilst the other received some, but that both plots received some lime, the amount being about twice as large in the second as in the first case. But there is another reason why these plots, which received annual applications of dung and gypsum, may fairly be included, and that is, that there is no reason, so far as one knows, why gypsum shall produce any benefit to the crop. The soil of the farm contains a sufficiency of this element. The results themselves support these arguments, for no general increase in outturn can be traced to the gypsum. I therefore include these two plots, and consider them as two, to which dung only has been applied, and credit any increase in outturn over the unmanured plots to the effect of the dung. In addition to these, there is an unmanured plot in another series of experiments situated not far from the Standard and Duplicate plots which I shall include, since it supports and adds to the value of the figures representing the outturn of the two

Plots selected for review.

Gypsum.

MANURE: Farm-yard. **Note on the value of**

CAWNPUR EXPERIMENTS.

unmanured plots above mentioned. In statement I the effect of dung on the wheat crop is shown.

Statement I.—Wheat grown at the Cawnpur Farm.

Effect on wheat.

	"Standard" series. No manure.	"Duplicate" series. No manure.	Green manure series. No manure.	Average of columns 2, 3, 4.	"Standard" series. Cattle dung 132 cwt. per acre.	"Duplicate" series. Cattle dung 132 cwt. per acre.	"Standard" series. Cattle dung 132 cwt. per acre plus 240 lb gypsum.	"Duplicate" series. Cattle dung 132 cwt. and 240 lb. gypsum per acre.	Average of columns 6, 7, 8, 9.	Increase due to dung.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	lb	lb	lb	lb	lb	lb	lb	lb	lb	lb
1881-82 .	777	771	...	774	918	738	882	594	783	+9
1882-83 .	1,065	999	...	1,032	1,113	1,623	1,761	1,886	1,745	+713
1883-84 .	1,031	7,281	1,515	1,609	1,428	3,031	1,364	3,004	2,206	+597
1884-85 .	635	1,025	623	761	900	1,466	887	1,396	1,162	+401
1885-86 .	913	1,119	1,367	1,133	1,537	2,021	1,857	2,069	1,871	+738
1886-87 .	1,041	1,258	847	1,048	1,258	1,270	1,162	1,488	1,294	+246
1887-88 .	968	907	786	887	1,245	1,222	1,210	907	1,145	+258
1888-89 .	883	617	653	718	980	992	1,174	944	1,022	+304
1889-90 .	1,307	1,876	1,464	1,549	1,585	2,856	1,525	1,513	1,869	+320
1890-91 .	1,222	1,591	1,162	1,358	1,537	1,779	1,767	1,706	1,697	+339
1891-92 .	992	956	690	879	1,331	1,573	1,258	1,174	1,334	+455
1892-93 .	1,500	1,754	1,500	1,581	2,474	1,894	2,378	2,305	2,262	+681

Column 1 contains the list of years through which the experiment has been carried.

Column 2 gives outturn of wheat in pounds per acre on the unmanured plot of the Standard series.

Column 3 gives the corresponding outturn of wheat for the unmanured plot of the Duplicate series.

Column 4 contains the outturn of wheat obtained on the third unmanured plot.

Column 5 gives the average for each year of these three plots.

Column 6 gives the outturn of the "Standard" plot on which cattle dung at the rate of 132 cwt. has been annually applied.

Column 7 gives the outturn for the corresponding plot of the "Duplicate" series.

Column 8 gives the outturn of the "Standard" plot on which cattle dung 132 cwt. and gypsum 240 lb have been applied.

CAWNPUR EXPERIMENTS.

Statement II.—Maize grown at the Cawnpur Farm.

	"Standard" series. No manure.	"Duplicate" series. No manure.	Average of columns 1, 2.	"Standard" series. Cattle dung 132 cwt. per acre.	"Duplicate" series. Cattle dung 132 cwt. per acre.	"Standard" series. Cattle dung 132 cwt. and Gypsum 240 lb per acre.	"Duplicate" series. Cattle dung 132 cwt. and Gypsum 240 lb per acre.	Average of columns 5, 6, 7, 8.	Increase due to dung.
(1)	(2)	(3)	(4)	5)	(6)	(7)	(8)	(9)	(10)
	lb	lb	lb	lb	lb	lb	lb	lb	lb
1881-82 .	1,239	...	...	633	...	1,218	...	...	...
1882-83 .	1,002	924	963	2,169	2,020	1,758	1,704	1,913	950
1883-84 .	990	802	896	1,462	1,170	1,644	979	1,314	418
1884-85 .	1,044	564	804	1,860	1,580	1,914	1,524	1,719	915
1885-86 .	339	194	266	266	605	436	641	487	221
1886-87 .	435	205	320	968	665	1,161	532	831	511
1887-88 .	...	...	...	...	...	...	...	...	...
1888-89 .	...	...	...	...	...	...	...	...	...
1889-90 .	278	302	290	1,500	1,573	1,150	1,355	1,394	1,104
1890-91 .	871	811	841	1,053	653	1,246	1,053	1,001	160
1891-92 .	544	629	586	883	665	1,815	944	1,077	491
1892-93 .	218	327	272	435	556	665	532	547	275

Effect on maize.

Column 9 gives the outturn of the corresponding plot in the "Duplicate" series.

Column 10 gives the average of the four plots which have been manured with dung.

Column 11 gives the increase which may be attributed to 132 cwt. Cattle dung.

8. The figures require very little remark. There has been an increase each year from the commencement. The first year thus amounted to only 9 lb, but the results of the first year may be fairly excluded from the comparison; agricultural experimental plots generally require one or two years in which to eradicate the effects of previous treatment.

Excluding therefore 1881-82, the increase has varied from 246 lb in 1886-87 to 738 in 1885-86. Approximately, it may be said that in two years the increase amounted to about 250 lb; in three years to about 300 lb; in two years to about 400 lb; in two years to about 600 lb and in two years to about 700 lb per acre.

9. Statement II contains the results obtained from the "Standard" and "Duplicate" series of plots on which maize has been annually grown since 1881-82. The statement in detail is similar to Statement I.

The results of this experiment with maize vary within much greater limits than do those with wheat, and it is possible that it is not so suitable a crop to experiment with. It is, moreover, much more liable to failure than wheat. In two years, 1887-88, 1888-89, the crop failed altogether, and in two other years, 1885-86, 1886-87, the crop was much below the average on nearly all the plots of both series.

Excluding the first year and the two years of total failure the increase due to cattle dung varies from 160 lb to 1,104 lb per acre. Approximately it may be said that in three years the increase was about 200 lb; in one year 400 lb; in two years 500 lb; in two years 900 lb and in one year 1,100 lb per acre.

MANURE: Farm-yard. **Note on the value of**

DUMRAON EXPERIMENTS.

Experiments at the Dumraon Farm.

10. No such extended series of experiments as those carried out at Cawnpur have been made at the Dumraon Farm. One series of plots has been manured during six years and a crop of wheat grown. This is the only experiment of a sufficiently reliable nature to admit of inclusion in this note. Statement III. contains the results; the increase due to 131 cwt. of cattle dung is contained in column 4. It will be seen that the increase due to the dung is much less than at the Cawnpur Farm. But the soil is a very heavy stiff clay, with no soil of a lighter nature below the surface soil, and this is probably a reason for poor average crops and small increase.

This soil reminds one of the stiff clays in England, which could not be brought under profitable cultivation until improved cultivation appliances had been introduced. The increase on this land has varied from 94 lb. to 476 lb.

Statement III.—Wheat grown at the Dumraon Farm.

	No manure.	Cattle dung 131 cwt. per acre.	Increase due to dung.
(1)	(2)	(3)	(4)
	lb	lb	lb
1885-86	1,158	1,514	+356
1886-87	516	610	+ 94
1887-88	672	908	+236
1888-89	884	1,154	+270
1889-90	910	1,386	+476
1890-91	606	866	+260

BURDWAN EXPERIMENTS.

11. *Results obtained at the Burdwan Farm.*—On a series of plots rice has been grown for the last four years at the Burdwan Farm, and on five of them no manure has been used at all. There is only one "Dung" plot. The value of this series is somewhat modified by the fact that leguminous crops have been grown in the intermediate season of the year, and what effect this may have had on the succeeding rice crop it is hard to say. Statement IV. contains the results. The figures in columns 2 to 9 represent pounds of paddy (not cleaned rice) per acre. Column 9 contains the increase of outturn obtained from the dunged plot over the *average* of the five unmanured plots. As will be seen, there are wide differences between the results, but the experiments have not been conducted sufficiently long to admit of any definite conclusion being drawn.

Statement IV.—Paddy grown at the Burdwan Farm.

	No manure (gram grown in alternate season).	No manure (wheat grown in alternate season).	No manure (peas grown in alternate season).	No manure (lentils grown in alternate season).	No manure (lentils grown in alternate season).	Average of columns 2, 3, 4, 5, 6.	Cattle dung 109 cwts. (peas grown in alternate season).	Increase or Decrease.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	lb	lb	lb	lb	lb	lb	lb	lb
1889-90 .	1,126	738	1,320	914	860	991	1,620	+629
1890 .	1,434	1,722	1,184	1,140	1,476	1,391	1,330	—61
1891 .	850	860	1,570	1,768	1,886	1,387	3,996	+2,609
1892 .	1,968	1,722	1,230	1,260	1,476	1,531	3,690	+2,159

NAGPUR EXPERIMENTS.

12. *Results obtained at the Nagpur Farm.*—At this farm there is one series of plots, A, which has received dressings of certain manures since 1884, the crop grown being wheat *unirrigated*. This series is still continued. Another series, C, treated in a similar manner, was commenced in 1884 and continued until 1890. A third series, B, of plots, receiving similar dressings of similar manures for the wheat crop, but *irrigated*, was commenced in 1890 and is still continued. Statement V. contains the results of the unmanured and dunged plots of each of these series.

Statement V.—Wheat grown at the Nagpur Farm.

	A			B			C		
	No manure (unirrigated).	Cattle dung 115 cwt. per acre (unirrigated).	Increase or decrease.	No manure (unirrigated).	Cattle dung 115 cwt. per acre (unirrigated).	Increase or Decrease.	No manure (irrigated).	Cattle dung 115 cwt. per acre (irrigated).	Increase or Decrease.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	lb	lb	lb	lb	lb	lb	lb	lb	lb
1884-85 .	1,055	1,003	—52	640	700	+60	...	...	...
1885-86 .	763	515	—148	700	915	+215	...	...	...
1886-87 .	1,060	1,550	+490	780	900	+120	...	...	...
1887-88 .	760	1,138	+378	733	710	—23	...	...	...
1888-89 .	525	350	—175	195	135	—60	...	...	...
1889-90 .	887	1,012	+225	687	512	—175	...	...	...
1890-91 .	515	937	+422	...	...	...	802	1,037	+235
1891-92 .	450	602	+152	...	...	...	642	1,095	+453
1892-93 .	230	312	+82	...	...	...	200	280	+80

It will be convenient to consider first the figures of the third experiment detailed in columns 8, 9, 10, because they are for *irrigated* land. It will be seen that the increase due to cattle dung, applied at the rate of 115 cwt. per acre, varies from 80 lb to 453 lb of wheat per acre. The columns 2, 3, and 4 contain the results of the A series, and columns 5, 6, and 7 contain those of the C series. The crop is not irrigated at all in either of these series. The outturns have varied enormously, and no deductions can be drawn from the results. This result I believe to be due in very great measure to the constant attacks of rust which interfere with many of the experiments at this farm. In the majority of years there has been an increase due to cattle dung.

Increase of outturn.

13. Excluding the results obtained at Nagpur, it will be seen that a very distinct increase in outturn of grain is obtainable by means of an application of cattle dung, amounting to several hundred pounds per acre.

But there is another factor which is of somewhat doubtful value, *viz.*, the quantity of dung applied for these crops No attempt has been made to determine how much cattle dung is at a cultivator's disposal, and it

MANURE: Farm-yard. **Note on the value of**

COMPOSITION OF CATTLE DUNG.

would have enhanced the value of the experiments considerably if this had been determined and a dressing of manure applied which would approximate fairly to that which a ryot would be able to apply. This estimation is now being commenced at several of the farms.

Regarding the composition of Indian cattle dung a few analyses are available. Two are quoted in Dr. Voelcker's Report, Appendix D, and I tabulate these below, to which are added analyses which I have made of some other samples. But these are useless by themselves: the weight per annum available is also requisite.

	Dung from lean cattle. (Voelcker.)	Dung from cart bullocks (Voelcker.)	Cattle dung from Cawnpur. (Leather.)	Cattle dung from grazing land, Poona. (Leather.)	Cattle dung from grazing land, Poona. (Leather.)	Farm-yard manure, Poona. (Leather.)
Moisture . .	19·59	17·86	70·26	65·07	10·73	36·19
* Organic matter .	59·26	61·89	10·54	13·67	43·10	25·53
** Mineral matter .	21·15	20·25	19·20	21·26	46·17	38·28
	100·00	100·00	100·00	100·00	100·00	100·00
* Containing nitrogen . .	1·34	1·08	·258	·483	1·008	·853
Equal to ammonia	1·62	1·31	·313	·586	1·224	1·036
** Containing insoluble siliceous matter . .	14·43	16·75				
Oxide of iron and allumina .	3·36	1·36				
Lime . . .	1·04	·85				
Magnesia . .	·44	·30				
Potash . . .	1·16	·60				
Soda	·34	·26				
Phosphoric acid .	·47	·54	·156	·124		
Equal to phosphate of lime . .	1·03	1·18	·340	·271		

COMPARED WITH GREEN MANURING.

The value of cattle dung compared with the effect of green manuring.

14. At both the Cawnpur and the Nagpur Experimental Farms, plots of land have been set apart to test the value of ploughing in a green crop in early autumn to act as manure for the cold weather wheat crop. At Cawnpur there are two series of such plots. In one case there are four plots and in the other there are two plots on which green crops (indigo or green *san*, **Crotolaria juncea**) are ploughed in towards the end of the monsoon. There is also an unmanured plot. These plots are all irrigated. At Nagpur there are three series of plots which have been subjected to a like treatment, two series being unirrigated, whilst a third has received artificial irrigation. This method of manuring land for a cold-weather crop is not unknown to Indian agriculture, it being practised in certain parts of Bengal and Bombay Presidency (*vide* Dr. Voelcker's Report, page 107). So far as the cost of the process is concerned, it may be estimated at the value of the seed employed and probably an extra ploughing. This does not amount to much, and it may be said to be a cheap method of manuring.

Statement VI.—Wheat grown at the Cawnpur Farm.

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
	Green indigo ploughed in.	Green indigo ploughed in with 480 lb gypsum.	Green *sann* ploughed in.	Green *sann* ploughed in with 480 lb gypsum.	Average of columns 2, 3, 4, 5.	No manure.	Increase or Decrease.	Green *sann* ploughed in.	Green *sann* ploughed in with gypsum.	Average of columns 9 and 10.	No manure.	Increase or Decrease.
	lb	lb	lb	lb	lb	lb	lb	lb	lb	lb	lb	lb
1881-82	...	...	...	...	...	...	...	1,713	2,244	1,978	777	+1,201
1882-83	...	...	...	...	...	...	...	1,619	1,855	1,737	1,198	+539
1883-84	2,358	2,396	...	2,260	2,338	1,515	+813	1,529	1,937	1,733	1,082	+651
1884-85	1,944	2,160	1,399	1,476	1,745	623	+1,122	1,377	1,431	1,404	659	+745
1885-86	1,494	1,845	1,138	1,083	1,390	1,367	+23	660	...	...	709	—49
1886-87	1,270	1,597	871	1,319	1,264	847	+417	1,500	...	...	751	+749
1887-88	920	617	907	871	829	786	+143	1,285	...	...	587	+698
1888-89	714	762	1,028	835	835	653	+182	814	...	...	447	+367
1889-90	1,670	1,319	1,972	1,452	1,603	1,464	+139	1,122	...	...	484	+638
1890-91	1,984	1,452	1,125	944	1,376	1,162	+214	1,113	...	...	635	+478
1891-92	1,270	1,367	1,004	1,307	1,237	690	+547	1,125	...	...	345	+780
1892-93	1,573	1,658	1,379	1,295	1,476	1,500	—24	...	...	...	...	...

MANURE: Farm-yard. **Note on the value of**

GREEN MANURE *versus* CATTLE DUNG.

The land must of course be lying otherwise fallow in the monsoon.

The Cawnpur Experiment.

Cawnpur.

15. The accompanying statement VI. is self-explanatory. In the first experiment (columns 2 to 8) are four plots on which a green has been ploughed in for a series of years, wheat, with irrigation, being the crop grown in the following cold weather. On one plot (column 2) a crop of indigo has been ploughed in; on a second (column 3) a crop of indigo has likewise been ploughed in, to which, however, has been added a dressing of 480 ℔ of gypsum per acre. On a third (column 4) a crop of *san* hemp, **Crotolaria juncea**, has been ploughed in; and on a fourth (column 5) a crop of *san* hemp has been similarly ploughed in, to which has been added a dressing of 480 ℔ of gypsum per acre. The two plots which received a dressing of gypsum may be fairly included in the comparison, for no general increase in outturn can be traced to its effect, nor is there any adequate reason for expecting this material to make any difference, unless the soil had been distinctly poor in lime, which it is not. Column 6 gives the average of these four plots for each year during which the experiments lasted. Column 7 contains the outturn of the unmanured plot, and column 8 shows the difference between the outturn of the unmanured plot and the average of the four plots on which a green crop had been ploughed in. This difference is a gain in every year but 1892-93, the increase varying from 23 to as much as 1,122 ℔ of wheat per acre. In the majority of years, however, the increase is much more uniform.

16. At another part of the farm the same method of manuring has been employed, and the results are contained in columns 9, 10, 11, 12, and 13. The experiment on the plot on which green hemp was ploughed in with gypsum was discontinued after the fourth year. For the period during which this plot was included, an average of the two is given in column 11. Column 12 contains the outturn of the unmanured plot, and column 13 the increase or decrease. In one year only was there a decrease. The land on which this experiment was made is probably much poorer than that on which the other series of plots is situated, and also probably poorer than the land on which the "Standard" and "Duplicate" series of plots are, for whilst the outturn of wheat was at first fairly uniform on these four plots, it has latterly decreased considerably on the "No manure" plot of this second series (green manuring). Concurrently the effect of green manuring has been enhanced. The increase shown as due to ploughing in a green crop in this second series is considerably greater than that obtained on the first series, which is made evident by a comparison of the columns 8 and 13 respectively.

Experiments made at the Nagpur Farm.

Nagpur.

17. As already mentioned, there are three series of plots at this farm on which a green crop, *san* hemp (**Crotolaria juncea**), has been annually ploughed in for a number of years. The comparative results will be found in Statement VII.

Statement VII.—Wheat grown at the Nagpur Farm.

	A	C		A	C			B		
	Green hemp ploughed in (unirrigated).	Green hemp ploughed in (unirrigated).	Average of columns 2 and 3.	No manure (unirrigated).	No manure (unirrigated).	Average of columns 5 and 6.	Increase or Decrease.	Hemp ploughed in (irrigated).	No manure (irrigated).	Increase or Decrease.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
	lb	lb	lb	lb	lb	lb	lb	lb	lb	lb
1884-85 .	940	915	928	1,055	640	847	+81	...	...	...
1885-86 .	250	228	239	762	700	731	—492	Linseed	grown.	...
1886-87 .	1,430	1,208	1,319	1,060	780	920	+399	Wheat	grown.	...
1887-88 .	803	893	848	760	733	746	+102	Linseed	grown.	...
1888-89 .	275	255	265	525	195	360	—95	Til	grown.	...
1889-90 .	767	582	674	887	687	787	—113	Til	grown.	...
								Wheat irrigated. (5)		
1890-91 .	760	...	...	515	...	...	+145	925	802	+123
1891-92 .	582	...	...	450	...	...	+132	632	642	—10
1892-93 .	312		...	230	...	...	+82	242	200	—42

The two series of plots, A and C, are comparable until 1889-90, when C series ceased. They are not irrigated. In the case of series B, the treatment of the plots was the same from 1884-85, but different crops occupied the land during the first six years, and it was not until 1890-91 that it was made a permanent experiment on the value of green manuring with irrigation for the wheat crop. There are therefore only three years' results to compare in this case.

The statement hardly requires any explanation. For the first six years the average outturn of the two plots in A series and in C series respectively, on which green *san* hemp was ploughed in, have been compared with the average of the corresponding two unmanured plots. Column 8 shows the amount of Increase or Decrease.

Columns 9, 10, 11, show the results obtained in the B series. As will be seen from the columns 8 and 11, the results obtained at the farm, which, as already mentioned, is situated on "black" soil, are quite discordant, and the only conclusion which may safely be drawn from them is that in the majority of years an increase in the outturn of wheat may be obtained with this method of manuring the land.

MANURE: Farm-yard.

Note on the value of Indian Cattle Dung as manure.

Difficulties of comparison.

But, as in the case of the employment of cattle dung for the wheat crop, so likewise here, very considerable obstacles present themselves to the obtaining of concordant results—chiefly due to constant attacks of rust.

There is a further difficulty which has been experienced at Nagpur, namely, that it has not always been possible to grow the crop of hemp owing to want of rain in the second half of the monsoon period, and, again, if the winter rains are scanty, the hemp crop does not appear to decompose sufficiently thoroughly to become of service to the plant. None of these difficulties seem to have been met with at Cawnpur. I have already explained in an earlier paragraph (6) of this note that it does not appear expedient to strike arithmetical means of the results of these experiments, and a numerical comparison of the value of cattle dung and of ploughing a green crop for manure, cannot therefore be given. Looking over the results as exhibited in the statements, it will be seen, however, that the increase due to ploughing in a green crop at Cawnpur and at Nagpur is approximately equivalent to a dressing of about 120 cwt. (6 tons) of cattle dung per acre.

Conf. with "The Ledger," No. 7 of 1894.

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Agricultural Chemist to the Government of India.

G. I. C. P. O.—No 293 D. R. & A.—8-7-95.—2,000.—II. R.

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THE

AGRICULTURAL LEDGER.

1894—No. 6.

RHEA FIBRE.

[*Dictionary of Economic Products, Vol. I.*, B. 576; *and Vol. VI., Pt. I.*, R. 172: *also* No. 27 *of Programme of Imperial Institute Operations for the year 1894-95.*]

A Note on Rhea Fibre, and on the Rewards formerly offered by the Government of India for machinery to be employed in its separation,—by THE EDITOR.

THERE are two questions of almost constant recurrence in official correspondence, *viz.*:—Does the Government of India continue to offer the reward of £5,000 for the best Rhea-extracting machine? Does India give promise of being a hopeful field for an extended production of Rhea fibre?

It has occurred to the writer that a note on Rhea fibre, in which these two questions may be answered, would very likely prevent much unnecessary correspondence and meet at the same time a public demand for information regarding this very valuable fibre. I shall therefore endeavour to answer these questions as briefly as possible:

RHEA-EXTRACTING MACHINERY.

FIRST OFFER OF A REWARD.

I.—A Notification of the Home Department, No. 145, published on the 11th January 1870, was to the following effect:—

"The Government of India, after communication with various Agricultural and Horticultural Societies in India, and with persons interested in the subject, has arrived at the conclusion that the only real obstacle to the development of an extensive trade in the fibre of Rhea, or China grass, is the want of suitable machinery for separating the fibre and bark from the stem, and the fibre from the bark, the cost of effecting such separation by manual labour being great.

"2. The demand for the fibre is now large, and no doubt might be extended with reduced prices, and there is a practically unlimited* extent of country in India where the plant could be grown.

*Conf. with p. 3.

"3. The requirements of the case appear to be some machinery or process capable of producing, with the aid of animal, water, or steam power, a ton of fibre of a quality which shall average in value not less than £50 in the English market, at a total cost (all processes of manufacture and allowance for wear and tear included) of not more than £15 per ton," etc.

"2. To stimulate the invention or adaptation of such machinery or process, the Government of India hereby offer a prize of £5,000 for the machine and process that best fulfils all the requirements named above," etc.

. . . . . .

"8. One year from the date of this advertisement will be allowed for the preparation of the machines and their transport to the locality named for the competition, and the trials will then be made and the decision of the judges announced. If no invention of sufficient merit is received in the above-named period to obtain the prize offered, the Government will continue to allow machines to be tendered for trial till the end of two years from the same date, after which, or on the award of the prize, the offer herein named will be withdrawn."

The above are the chief features of the first advertisement. Some thirty-two competitors entered their names, but at the last moment only one, a Mr. Greig of Edinburgh, appeared in India. The trial took place at Saharanpur in August 1872, where a plantation of Rhea had previously been established for the purpose. It was found that the fibre produced by Mr. Greig's extractor cost more than the sum specified in the advertisement, while at the same time it was of such inferior quality as to realise but £28 a ton, and was declared as fit only for cordage. Under these conditions the full amount of the award could not be given, but the meritorious attempt which had been made by Mr. Greig to meet the requirements was thought deserving of a donation of £1,500 towards the expenses he had incurred.

SECOND OFFER OF A REWARD.

II.—By Notification No. 45, of the 31st August 1877, the Government of India a second time made known its willingness to give a substantial award to the inventor of a process or contrivance that might be found to fulfil the specifications of a Rhea-fibre-extracting machine.

In this second notification the following passages occur :—

"Fifty thousand rupees will be paid to the inventor of the best machine or process which will separate the bark and fibre from the stem, and the fibre from the bark, of **Bœhmeria nivea.**

"A smaller reward, not exceeding ten thousand rupees, will be given to the inventor of the next best machine or process, provided it is adjudged to possess merit, and to be capable, without difficulty of adaptation, to practical use.

"What is required is a machine or process capable of producing, by animal, water, or steam power, a ton of dressed fibre of a quality which shall average in value not less than £45 in the English market, at a total cost, including all processes of preparation and all needful allowance for wear and tear, of not more than £15 per ton, laid down at any port of shipment in India and £30 in England after payment of all charges usual in trade before goods reach the hands of the manufacturer.

"The machinery employed must be simple, strong, durable and inexpensive, and should be suitable for erection in the plantations where the rhea is grown. It must be adapted for treatment of the fresh stems as cut from the plant. The treatment of dried stems offers certain difficulties, and the fibre prepared from them must, moreover, always be much more costly than the fibre produced from green stems. Except during the hot dry weather preceding the rains in Upper India, it is very difficult

so to dry the stems that no fermentation or mildew shall occur. But during this season the stems are comparatively short and the crop poor and stunted, unless it is artificially irrigated, and such irrigation greatly increases the cost of cultivation. In the rainy season the plant is in fine condition, but at this season it is almost impossible to dry the stems in quantity without injuring the fibre, unless recourse is had to artificial means of desiccation, which greatly increase the cost of the material. It is therefore obvious that the attention of inventors should be given to the discovery of a process for treatment of the green stems."*

*Conf. with p. 5.

It is perhaps needless to quote the minor details of the notification here briefly indicated. The above passages will be found to not only convey the main principles enjoined, but to deal with certain peculiarities of rhea cultivation and of the requirements of the machinery necessary for India, and these hold good to the present time. The trials were fixed to commence on the 15th September 1879. Twenty-four competitors applied for permission to take part, but only ten ultimately appeared. The fibres produced by the various machines were in time sent to Europe for valuation, but as none of these, according to the report subsequently obtained, procured a price approaching the amount fixed as necessary, the Committee did not recommend the grant of either of the prizes. The Committee was, however, of opinion that certain of the machines possessed sufficient merit to warrant the grant of certain special awards. **Messrs. Nagona** and **Vander Plaeg** each obtained a special grant of ₹5,000 and ₹1,000 was paid to **Mr. Cameron** for the machines shown by these three gentlemen.

WITHDRAWAL OF REWARD.

III.—The Government of India in a Resolution dated March 19th, 1881, reviewed the Report of the Committee which had sat to examine the machines and *withdrew the offer of any further rewards.* The following passage occurs in that Resolution :—

"From the low valuation put by the English firms on the samples of fibre produced at the late competition, it does not seem probable that Indian rhea fibre will be able, for the present at least, to compete successfully with the Chinese product; while the experience which has been so far gained also points to the conclusion that *in most parts of India the cultivation of rhea cannot be undertaken with profit.* Rhea is naturally an equatorial plant, and it requires a moist air, a rich soil and plenty of water, while extremes of temperature are unfavourable to it. Such conditions may be found in parts of Burma, in Upper Assam and in some districts of Eastern and Northern Bengal, and, if rhea can be grown in such places with only so much care as is required in an ordinary well-farmed field for a rather superior crop, it is possible that it may succeed commercially. Until, however, private enterprise has shown that the cultivation of the plant can be undertaken with profit in these or other parts of the country, and that a real need has arisen for an improved method of preparing the fibre, in order to stimulate its production, *the Government of India think it inadvisable to renew the offer*, which it has now made for the second time without result, of rewards for suitable machines."

Conf. with pp. 1, 6.

It will thus be seen that one direct result of these trials was to create a doubt as to the suitability of India as a rhea fibre producing country, at least on a very greatly extended scale to what is practised by the Natives in a few isolated localities. The above passages

may, however, be accepted as fully answering the first question. stated in the opening paragraph, and it need scarcely be added that up to the present date the Government of India has not seen cause to depart from its Resolution of 1881, so that no rewards are at present offered for Rhea-fibre-extracting machinery. An attempt may therefore be made to answer the second question, *viz.*,—

DOES INDIA GIVE PROMISE OF BEING IN THE FUTURE A HOPEFUL FIELD FOR RHEA FIBRE PRODUCTION?

The Rhea and China-grass Plants.

Forms of the Rhea Plant.

According to **Sir J. D. Hooker** (*Flora of British India, V., 576*), **Bœhmeria nivea,** *Gaud.*, is a native of the Malay Islands, China and Japan, but is cultivated in the warmer parts of India, especially Assam and Bengal.

Roxburgh—the father of Indian botany—first became aware of Rhea on cultivating plants obtained from Sumatra, but he was shortly after (through the researches of **Dr. Buchanan-Hamilton**) shown what he identified as the same plant from Rungpore in Bengal. He seems to have been aware that there was a somewhat similar plant in China, and accordingly he points out the difference between his Malay and Bengal plant and that described by **Louriero** as **Urtica nivea.** **Gaudichaud** (*in Bot Freyc. Voy., pp. 499 & 500*), **Weddell** (*Monogr., p. 380*), and other botanists have also attempted the separation of the two forms. Modern writers regard these, however, as only varieties, and some even hold that they are at most but cultivated states of a common species. A few years ago the writer, in the first volume of the *Dictionary of the Economic Products of India*, ventured to point out that, whatever view botanists might ultimately uphold, there was a practical consideration of the greatest value that hinged on the controversy. This may be here briefly stated, *viz.*, that the plant that yields the true China-grass is met with in cultivation in tracts of country that have a sub-temperate climate, while the Rhea—that is to say, Malay and Bengal stock—occurs in moist tropical regions. The latter is, moreover, a more robust plant, has longer and narrower leaves with white tomentum on the veins of the under-surface only; while the former has large broad leaves with the base sub-cordate cuneate and densely coated below with adpressed white hairs. Now, if this distinction holds good, it would obviously be a mistake to attempt the cultivation of the temperate-loving plant in the tropical plains of India. But so far as can be ascertained this is actually what has been done in the majority of experiments hitherto conducted in India. From time to time fresh supplies have been imported from China and distributed all over this country, so that India may fairly be characterised as having fully attempted the acclimatisation of the China-grass, but done little or nothing towards endeavouring to extend the production of what (for the sake of convenience of expression) we may characterise as its indigenous

by the Editor.

stock. On this subject Mr. W. T. Thiselton Dyer (Director of the Royal Botanic Gardens, Kew) has written—

"The point raised by Dr. Watt, from the botanical point of view, has been dealt with by Sir Joseph Hooker in the *Flora of British India.* The further distinction in adaptability to climatic conditions, which chiefly concerns planters, has been observed in nearly every part of the world where these plants are grown for fibre purposes. The Ramie or Rhea, properly so called, may be looked upon as the tropical representative of the China-grass, and it is on that account probably better adapted for cultivation in hot and moist countries. Under such conditions it is a very robust plant and yields valuable fibre.

Different qualities of Fibre.

"Whether this fibre is at its best really as good as the best China-grass (**Bœhmeria nivea**) is a point that appears not to have been definitely settled. It may turn out to be simply a question of soil or climate. At Kew we find that we cannot successfully grow **B. tenacissima** in the open, whereas **B. nivea** itself remains in the ground all the winter, and furnishes in the summer a large crop of vigorous stems. The China-grass may, therefore, give a larger and better supply of fibre under cool conditions, whereas the Ramie or Rhea may do equally well under essentially tropical conditions. The question as regards India may be settled by cultivating under various conditions of climate and soil authentic specimens of each plant, and by instituting, as suggested by Dr. Watt, a careful chemical and microscopic analysis of the fibres yielded by Indian-grown plants of what are known to be the true **Bœhmeria nivea** and the true **B. tenacissima.**"

AREAS SUITABLE FOR RHEA AND CHINA-GRASS CULTIVATION.

AREAS SUITABLE.

Enough has perhaps been said to justify the assumption that, for all practical purposes, it may be said there are two forms of the plant—the one, the China-grass, a temperate, and the other, the Rhea, a tropical plant. That being so, the areas in India suitable for the one form would be entirely different from those for the other. But, speaking collectively, it may be said that the opinion entertained in 1870 and inculcated in the first Notification regarding awards, that the want of suitable machinery is the "real obstacle to the development of an extensive trade," has been abundantly shown to have been fallacious. Infinitely greater obstacles exist in the absence of suitable tracts of country, in the opposition of the Native cultivators to engage in the undertaking, and in the exhausting nature of the crop, which necessitates heavy manuring to preserve the fertility of the soil. The plant is a perennial, and is not therefore, like jute or sunn-hemp, capable of being restricted in its cultivation to the months of the year suitable to it. The marked transitions from the dry hot season to the damp hot season and again to the cold season are unfavourable to the uniform growth of the stems, and the fibre is accordingly distorted. During the hot season the plant practically ceases to grow, but with the rains it springs into long succulent stems which, as already mentioned, must be treated in the fresh state owing to the difficulty that for some time after the cessation of actual rain exists in drying them. This is all the more to be regretted

Chief obstacles.

Conf. with p. 3.

Difficulties of Rhea Cultivation.

since, bearing in mind the financial condition of the ordinary cultivator, it has to be admitted that few could afford to purchase machinery for separating the fibre. Success, if attained, would have to be looked for in the direction of the erection of decorticating factories to which the stems could be consigned by the cultivators. If damp stems had to be carted for a greater distance than could be accomplished in a few hours, it is more than probable that they would arrive in a state of fermentation, if not of decomposition, that would render them perfectly useless. The poverty of the Indian *rayat* is such that the iron tank in which to boil the stems, recommended in the **Fleury-Moriceau** process, would be beyond his means Were it possible to enforce cultivation within a restricted radius around a central factory, or to offer such inducements as to secure an extensive and constant cultivation within a limited area, then machinery owned and worked by Europeans might be erected to deal with green stems. But past experience in Indigo manufacture is likely to retard capitalists from embarking in an enterprise that might at any moment be confronted with the total cessation of supply. To be safe, therefore, the stems would have to be drawn from an extensive area, and to lessen freight (were there no other considerations) they would have to be sold in a dry state. It might be quite otherwise were planters to take the matter into their own hands and grow rhea on estates of their own, as in the case of tea and coffee. In other words, it will take some centuries before the Indian cultivators see the advantages of purchasing special machinery for a new crop. They have not even at the present day discovered the economy of time, and hence money value of the commoner appliances of European agriculture. They continue, as their fathers did, to reap their crops with a small pruning-hook, to tread out the corn by the feet of the patient bullock, and to look to the breezes that blow to winnow in handfuls their grain. With such a backward state of agriculture the profits from rhea cultivation would have to be demonstrated as far greater than they are ever likely to be, before the *rayat* could be induced to spend more than a very few rupees in the purchase of necessary apparatus.

Rhea Estates.

Area very restricted.

These considerations will, therefore, be seen to restrict still further the areas of India that are likely to become available for Rhea or China-grass cultivation. The Government of India in a Note on this subject published on the 23rd November 1885 give a summary of the opinions arrived at in India :—

Conf. with pp. 1 & 3.

"There appears (the Note states) to be a very general impression prevailing in England, and to some extent in India, that this country is on the whole well suited for the extensive cultivation of the rhea plant. This is not the case, and as many enquiries have been recently received from various sources asking for information, and in some cases for grants of land and other assistance from Government, it seems desirable that the existing evidence on the subject should be made generally known. The fact is that the greater part of India is unsuited for the profitable cultivation of rhea as a commercial product, although it may be quite true that the plant will grow anywhere in India."

by the Editor.

Prospects.

The Note then reviews the experiments performed at Saharanpur and Calcutta, and very properly characterises these as "garden cultivations," but "even so they have not been successful."

"The only chance is to look for places where the natural conditions are as like those of Sumatra and Java, etc., as possible,—where there are no extremes, where the soil temperature is not too low in winter, and where there is plenty of moisture. Burma is probably out of the question, because of the labour difficulty. The only districts that do not seem hopeless are Upper Assam, Dacca, Dinajpur, Southern India, etc.: no flooded land is of the least use—floods kill the plant."

The Note then concludes as follows:—

"At present, however, India cannot be looked upon as a favourable field for the Rhea industry."

Conclusion.

In conclusion it may therefore be said that the only escape from these very unfavourable opinions would seem to be in the hope that when **Bœhmeria nivea** and **B. tenacissima** are separately recognised and cultivated as plants with widely different characteristics, better results may here and there be attained than hitherto. It is not, of course, impossible that by careful selection an acclimatised stock of the former might be evolved, suitable for certain tracts of India. But failure was unavoidable when the temperate plant was tried (as in many of the past experiments) as an immediate crop on tropical fields. At the present day the most successful centres of Rhea and China-grass cultivation may be said to be at Rungpore, Dinajpur, and Tirhoot, Districts of Bengal, for the former; and at Holta in the Kangra District of the Panjab and at the Wynaad of Madras, for the latter. It would seem undesirable to give here details regarding these centres of cultivation, seeing that that information may readily be obtained by consulting the account as given in *The Dictionary of Economic Products*, Vol. VI., Part I., pages 465 to 476. Suffice it therefore to add, that the *kankhura* of Bengal is the indigenous or at all events fully acclimatised stock, the cultivation of which should be attempted on the tropical plains of India, while the Chinese plant now more or less acclimatised in Kangra and the Wynaad would be more desirable for experimental production on the hill tracts than freshly-imported supplies. The success or failure of the future will depend entirely on the spirit displayed by those who attempt to solve the problem of the cultivation of the plant.

GEORGE WATT,

September 1st, 1894. *Reporter on Economic Products.*

THE

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NITROGEN, ASSIMILATION OF, BY PAPILIONACEÆ.

[*Dictionary of Economic Products, Vol. V.*, N. 169 a.]

1. *Review of the Literature of Hellriegel's Discoveries by* PROF. T. H. MIDDLETON, *Baroda.*
2. *Note on the same by* DR. J. W. LEATHER, *Agricultural Chemist to the Government of India.*
3. *Introductory Note and concluding remarks on Peculiarities in the Distribution of certain of the Indian Leguminosæ—by* THE EDITOR.

Microbes of the Soil.

[IT might almost be said that no discovery of modern times, in the field of biology, has given promise of being of greater or even equal value to that of Hellriegel. So long ago as 1876 Berthelot suggested that microbes in the soil very possibly exercised an influence on plants by enabling them to absorb nitrogen. This Hellriegel has demonstrated to be actually the case. He has shown that certain plants form on their roots minute tubercles within which advantageous microbes are, as it were, housed. This discovery has been confirmed by Wilforth as well as by Lawes & Gilbert and many other observers. It may be said to have not only revolutionized our knowledge of the methods and materials of plant nourishment, but to have given a completely new turn to scientific agriculture. It has materially advanced the investigations into the subject of the preservation of soil fertility and has given a rational explanation of the value of certain leguminous crops, in the rotation that for centuries has been an accepted maxim in most civilized countries.

Soil Fertility *Conf. with p. 7.*

Nitrogen of the Atmosphere.

Theodore de Saussure originally raised the question whether the nitrogen of the atmosphere was utilized by plants in the formation of the nitrogenous materials of their structure. Boussingault demonstrated that this was not so, but that they derived their nitrogen through the roots, from compounds in the soil that contained that element. On this subject Prof. Julius von Sachs (*Lectures on the Physiology of Plants, translated by Prof. Marshall Ward, 1887*) says:—

"The view was once held that it was ammonia salts particularly which being absorbed by the roots of plants, or perhaps indeed by their leaves

Nitrogen of the Soil.

in the dew and rain water, yielded the nitrogen for the proteid compounds of the plant. But the result of our water-culture proves, in the first place, that plants are able at any rate to absorb the whole of their nitrogen in the form of compounds of nitric acid; but if, on the other hand, the attempt is made to replace the latter by ammonia salts, experimental difficulties make their appearance which we will not here discuss in detail. If, further, it is remembered that the ammonia produced in nature by the rotting and decomposition of organic remains, especially in vegetable soil, is easily transformed in the presence of potassium salts into compounds of nitric acid, which may be detected everywhere in vegetable soils and waters, and that nitric acid is contained in rain water, although in very small quantities, one comes to the conclusion that (apart, perhaps, from certain special cases and particularly apart from parasites and fungi) ordinary green plants obtain the nitrogen for the formation of their proteid substances, and therefore of their protoplasm, from salts of nitric acid."

Ammonia. *Conf. with p. 8.*

Nitric Acid.

Absorption of free Nitrogen.

Now, when a work published only the other day and by one of the greatest of botanists, affirms that plants obtain the whole of their nitrogen from compounds referable primarily to nitric acid, and when it has to be added that since the publication of that work it has been demonstrated that certain plants at least have the power, through the agency of microbes, to draw on the atmospheric supply of pure nitrogen, it will at once be apparent how great a revolution has been thereby effected in the theory of plant-life. And this is what has actually taken place within the past few years.

The Value of Pulse Crops. *Conf. with p. 8.*

The well-ascertained fact that while peas, beans, and other papilionaceous plants develop a high percentage of nitrogenous material, the yield of that substance is not proportionately increased by the addition of nitrogenous manures to the soil on which they are grown, is at once explained. So also the further fact that on crops of that nature being removed from the soil, they leave it richer in nitrogenous matter than before cultivation. On the roots of such plants minute tubercles are formed. These, it has been ascertained, contain microbes which have the power of building up within their bodies the atmospheric nitrogen that has permeated through the soil. On the death and decomposition of these microbes the foster plant is supposed to utilize the nitrogen compounds thus formed, and the soil is presumed at the same time to be enriched, through the cultivation of plants which possess the valuable property of harbouring these minute parasites.]

The Editor has had the pleasure to receive two communications on this most interesting subject, and as these trace out the history of the discovery and give many practical considerations, nothing further need be said by way of introduction :—

A Review of available Information on the Assimilation of Nitrogen by certain plants which belong to the Sub-order Papilionaceæ of the Natural Order Leguminosæ, by* PROF. T. H. MIDDLETON *of Baroda.*

THE OLD THEORY.—The source from which green-leaved plants derive their nitrogen has long been a debated question among scientific men.

* The facts contained in the following pages have been chiefly derived from the writings of Lawes & Gilbert and from the American Experiment Station Records.

THE OLD THEORY.

Before the close of the last century, the subject had received attention from T. de Saussure; and he came to the conclusion that the higher plants obtained no part of their nitrogenous food from the free nitrogen of the atmosphere; this view was subsequently combated by Ville, who, as the result of experiment, affirmed that plants absorbed and used free nitrogen gas, as well as ammonia and nitric acid. Boussingault concluded, from his earliest experiments (1837), that cereals were unable to absorb free nitrogen from the air, but that leguminous plants, by the aid of their broad leaves, might possibly do so. After further investigations (1851-55), conducted with sterilized soils and in an atmosphere free from combined nitrogen, he gave up this latter idea; and when his experiments were confirmed by those of Lawes & Gilbert at Rothamsted in 1857 and 1858, it was generally acknowledged by scientific men that the free nitrogen of the air played no part in the nutrition of the higher plants.

Free Nitrogen not Absorbed.

The experiments upon which this general conclusion was based were, from the chemist's standpoint, perfect. The plants were grown on calcined sand and in an atmosphere from which every trace of combined nitrogen had been excluded; they were supplied with mineral food but not with combined nitrogen, and therefore the fact that they did not increase in nitrogenous substance proved that when grown on *sterilized soil*, none of the higher plants possess the power of assimilating free nitrogen from the air. But at the time these experiments were being carried out it was freely admitted that a sterilized soil was not a natural one, though it was argued that calcining the sand used could have no appreciable effect on the question at issue.

Sterilized Soil.

Objections to the Old Theory.

Causes of its Rejection.—For twenty years after the publication of Lawes & Gilbert's corroboration of Boussingault's theory it may be said to have been an agricultural heresy of the rankest kind to believe that green-leaved plants fed directly or indirectly upon the free nitrogen of the air; but there were certain facts which the accepted opinion found it hard to account for, and on these facts a few heretics fed their doubts. Above all others, the two subjects over which the orthodox theory stumbled were (1) the source of nitrogen to leguminous crops, and (2) the maintenance of the balance of combined nitrogen in nature.

Loss of Nitrogen.

Leguminous crops, it was well known, were almost independent of nitrogenous manures. They contained much nitrogen in their substance, and generally left a soil in which they had been grown richer in nitrogen than before, while they refused to respond to the nitrates or ammonium salts,—manures highly beneficial to cereals. At the same time many observers had recorded that the sources of combined nitrogen were altogether insufficient to meet the loss which cultivated soils were undergoing; in other words, it was known that soils suffered far less than theoretically they might be expected to do; hence it had to be admitted as extremely probable that there were undiscovered sources of combined nitrogen from which plants were drawing a portion at least of their supplies.

THE NEW THEORY.

The New Theory.—In order to throw light on these questions the subject was again taken in hand, about the year 1876, and experiments were in active progress for nearly ten years before any material advance was made. The credit of the first result of importance belongs to the French chemist Berthelot. He drew attention to the fact that microbes in the soil exercised some influence on the fixation of nitrogen. His discovery did not attract very general attention, but, happily for Agricultural Chemistry, it attracted the notice of Hellriegel, a German chemist, who for three years had been conducting experiments with growing plants.

THE NEW THEORY.

Hellriegel's experiments had been of the usual description. He grew peas, oats, and barley on washed sand supplied with mineral plant food, but free from combined nitrogen, and he found, as others had done, that the cereals died off when the nitrogen of the seed was exhausted; that some of the pea plants behaved in a similar manner, but that the majority of pulses, after passing through a period of nitrogen-hunger, recovered and grew luxuriantly. He observed that on the roots of those that survived numerous tubercles had been formed (it had been suspected for many years that such tubercles were caused by micro-organisms), whereas the plants that died were without these excrescences. Knowing that Berthelot attributed the power of nitrogen fixation to micro-organisms, Hellriegel determined to test whether the tubercles were in any way connected with the nutrition of the peas. He accordingly planted peas in pots of nitrogen-free sand, and when the plants began to show nitrogen-hunger, he watered the sand with an extract from a fertile soil which was presumed to contain tubercle germs. As a result the plants in the watered pots developed tubercles on their roots and grew strong and healthy, whereas the majority of the plants in the non-infected soils produced no tubercles and died away. Hellriegel therefore concluded that papilionaceous plants have the power of obtaining atmospheric nitrogen through the agency of the organisms found in the tubercles on their roots.

Value of Root Tubercles.

HELIRIEGEL'S DISCOVERIES CONFIRMED.—The announcement of this theory caused the greatest interest in the agricultural world, and numerous scientific men at once began to study the subject. The original experiments were repeated and the results corroborated by Wilforth (1887), by Lawes & Gilbert (1887-90), by Prazmowski (1888-90), by Laurent (1890-91), and by several other investigators.

Impregnating soil with the germs. *Conf. with pp. 5, 6.*

ABSORPTION OF FREE NITROGEN.—Hellriegel himself repeated his experiments, using sterilized, instead of washed, sand as in the first instance. Prazmowski, who had devoted much attention to the study of the tubercle organism, successfully substituted pure cultures of the germ for the soil-extract, thus proving that the tubercle is due to a specific organism. Laurent, by growing papilionaceous plants in a closed apparatus, showed that the free nitrogen of the atmosphere lost just so much as the plants gained, and thus he proved indubitably that the air is a source of nitrogenous food to at least certain plants.

Demonstration of Absorption of Free Nitrogen.

Nature of the Tubercle Organisms.

THE ROOT-TUBERCLE.—The nature of the tubercle organism itself seems still to be doubtful. The following are the chief facts that have hitherto been published with respect to its character.* The tubercles on the roots of leguminous plants were supposed to be insect galls, but in 1866 Woronin discovered that they contained bacteria-like organisms which he called *bacteroids*. In 1874 Erickson came to the conclusion that the tubercle organisms were fungi. Ten years later this was denied, and it was announced that the turbercles were normal growths and not due to infection from without. In 1886 Hellriegel's discovery showed that the tubercles were produced as the result of infection, and in 1887 Marshall Ward confirmed Erickson's statement as to the fungoid nature of the organisms. The important office attributed to the tubercles by Hellriegel now drew much attention to them, and in the next three years several valuable investigations into their nature were conducted in France and Germany.

Beyerinck, extending his researches from peas to other papilionaceous plants, found that tubercle organisms were general; by growing in pure

* Taken from a valuable review of the literature on the subject by H. W. Corm in the American Experiment Station Record, Vol. II., p. 686.

cultures he found that there were many forms all closely resembling each other. He regarded them as bacteria and so nearly allied to each other as to be of one species, to which he gave the name **Bacillus radicicola.** In 1890 Prazmowski published an account of the most complete series of investigations that has hitherto been undertaken on these organisms. He agreed with the last author that they were bacteria (**Algæ**), and he proposed the name **Bacterium radicicola.** This bacterium lives normally in the soils, and is specially abundant in soils in which leguminous plants have been growing. Numbers collect round the young roots and penetrate them; inside the plant they undergo several changes of form; they give rise to tubercles by the irritation which they cause, and they finally degenerate and are probably consumed by the plant.

Tubercle Organism.

Algæ *versus* Fungi.

The French biologist Laurent came to a different opinion with respect to the nature of the organism. He succeeded in obtaining tubercles on plants grown in water, and had thus facilities for studying the subject; he agrees with Erickson & Ward in thinking the microphyte a member of the great family of **Fungi.** He has accordingly given it the name of **Rhizobium leguminosarum.** He successfully inoculated the pea from the tubercles of as many as thirty-six different species of plants, and concludes, therefore, that the organisms on different plants are closely allied, but from the diversified results obtained by inoculation, that they are not identical. Hellriegel found that in some cases the organisms were so distinct that infection with a lupine soil-extract would not produce tubercles on peas. Investigations on the tubercle organisms are still in progress, and in Germany at least experimenters agree with Prazmowski that the organism is a bacterium, and it is also generally believed that different forms are associated with different species of leguminous plants.

Inoculation of Soil. *Conf. with pp. 4, 6, 9.*

Method of Nitrogen Assimilation.

Method of Assimilation of Nitrogen.—The way in which the bacteria aid the pulses to obtain nitrogen is even more obscure than the nature of the organisms. Prazmowski has suggested three ways in which the higher plant may be benefited—(1) the bacteria may produce certain substances which enable the plant to fix free nitrogen in some compound which can be assimilated; (2) that the bacteria feed on free nitrogen and the foster plant feeds on the bacteria; (3) that the plant with the aid of the bacteria is able directly to assimilate free nitrogen.

Of these three possibilities Prazmowski considers the second most probable. Lawes & Gilbert hold a similar view. They think it very likely that free nitrogen is fixed by the organisms within the nodules, and that the leguminous plant can make use of the compound so formed. But beyond the fact that the tubercle organisms somehow or other aid the plant to obtain nitrogen, little is known, and the latest writers on the subject, Nobbe & Hiltner (quoted in the Experiment Station Record of August 1893), maintain that the bacteria themselves have nothing to do with the nitrogen assimilation, but that they give rise to degenerate forms —*bacteroids*—which are the real messmates of the plant.

OPPONENT TO NEW THEORY.

Opponents to Hellriegel's Theory.—Although generally believed in, Hellriegel's views are by no means universally accepted, and one school of biologists, of whom Professor B. Frank is the most prominent member, entirely denies his conclusions. Frank's opinion is that all green-leaved plants when well developed have the power of assimilating free nitrogen, but that after the nitrogen of the seed has been exhausted, cereals and most other plants are not far enough developed, and are too weak to find their own nitrogen, and must therefore have nitrogenous manures; leguminous plants, on the other hand, being stimulated to a strong root development, by the presence of the tubercle organisms, are

Assimilation of Nitrogen by Algæ and other Plants.

independent of manures. He admits that the tubercle organisms are of some use to the plant, but only as stimulating greater root development.

It has recently been shown by Laurent & Schlœsing that certain algæ have the power which Frank claims for all plants, of fixing free nitrogen; and Nobbe has found that a flowering but non-leguminous plant, **Elæagnus angustifolius** (=E. **hortensis**, found in the Himalaya), which has tubercles on its roots, has also the power to fix free nitrogen, so that it is possible that future research may prove this special power to be more common than is now supposed. Especially does there seem to be a likelihood that plants of low organization, algæ and others, may have an important place in supplying nitrogen to higher forms of vegetation.

Practical Results. *Conf. with pp. 4, 5.*

PRACTICAL RESULTS.—Hellriegel and his colleague Wilforth have recently been engaged in developing the practical side of their discovery. They naturally concluded that if soil inoculation produced such striking effects upon plants growing in pots, it should also do so on plants growing in soils where the tubercle organisms were deficient. Field experiments made by them showed these surmises to be correct, and soil inoculation was found to produce an effect on pulses similar to that produced by nitrogenous manures on cereal crops. In Wilforth's last published experiments, the best results were got by inoculating the soil of a field in which a leguminous crop was to be sown, with from one to one and a half tons of soil from a field in which the same crop had grown luxuriantly in the previous year.

Conf. with p. 12.

A further outcome of Hellriegel's discovery has been to draw greater attention to the growth of leguminous crops as a means of enriching soil. Formerly it was thought that the only addition made to the soil by a green manure was carbonaceous material, and that if the surface soil did show an increased percentage of nitrogen, the increase had taken place at the expense of the subsoil. Now, however, we may believe that the increase is due to the fixation of the free nitrogen of the air, of which there is an unlimited supply to be had for the taking, and as a result much attention is being given to the growth of "Nitrogen-gatherers," as papilionaceous plants have now come to be termed.

In India the increased production of leguminous crops as green manure is a subject which deserves the close attention of the Agricultural Departments. Both the necessity for nitrogenous manure, and the facilities for employing the system of green manuring, are greater in this country than in Europe. In a tropical climate the organic matter of the soil, and with it nitrogen, is rapidly dissipated, and its restoration by the ordinary European plan is next to impossible. Meat-production with its accompaniments,—purchased foods and rich manures,—has no place in our rural economy. The ryot's stock consumes the straw raised on his fields; the dung is usually burnt, and it is not to be wondered at, therefore, that nitrogen should be *the* element most required by our soils.

Green Manuring. *Conf. with The Agricultural Ledger No. 20 of 1893.*

GREEN-MANURING WITH PAPILIONACEOUS PLANTS.—But if our necessity for the use of nitrogen-gathering plants be greater than in Europe, so also are our opportunities for employing that system. In many of our papilionaceous plants, and especially in *sann* (**Crotalaria juncea**) and in *Gavar* (**Cyamopsis psoralioides**) we have the strong growth requisite in plants suitable as green manures; our climate, too, forces rapid growth, and if the rainfall be favourable or irrigation available, a catch crop may be taken without in any way interfering with the principal crops of the year. The ryots in some parts of India—*e.g.*, Navsari—are fully alive to the advantages of green-manuring; they cleverly work *sann* into a rotation of garden crops, and the wide extension of this practice is most desirable. But the use of green manures need not

be limited to irrigated lands. In many parts of India fields are fallowed through the first part of the monsoon with the object of sowing some early cold-weather crop in August or September; there is no time for two full crops, but *sann* might be sown and ploughed in as a green manure. In Gujarat, for example, it would be possible to grow *sann* before rape, tobacco, sesamum, castor-oil and a good many other common crops, and the green manure would not only add carbon and nitrogen to the soil, but would prevent soluble salts from being washed out by heavy rain. **Practical Results.**

Soil inoculation, like green-manuring, is a practice which could easily be adopted in India, and it might prove of value in growing crops, which, like peas and lucerne, require heavy manuring.

Mixed Crops.—It is possible that when a papilionaceous crop is grown mixed with a non-papilionaceous, the latter may derive some benefit from the nitrogen fixed by the former. In the common mixture of pulses and cereals it is improbable that the latter could derive much benefit, because the growth of the cereal is nearly completed before the pulse develops; but this is not always so, and in the case of cotton growing along with indigo or guinea-grass with lucerne it is likely that the non-leguminous plant derives some benefit from its neighbour. Such mixtures as the above are therefore desirable. **Mixed Crops.**

One further practical outcome of Hellriegel's discovery may be pointed out. It is frequently asserted that the soil of India is being despoiled, and that, cultivated as it is at present, the yield must diminish. The writer is not disposed to subscribe to this view. There is no doubt that every season's crop removes some of the soils' store, but that, taking the country as a whole, cropping does so any faster than Nature restores the loss, it is impossible to prove. Nitrogen, the element most deficient in our soils, might formerly have been maintained to have been undergoing loss, but now that we have learned that the organic matter of the soil and the nitrates, nitrites, and ammonium compounds carried down by rain from the air are not the only sources of nitrogen to our crops, it seems quite possible that the annual losses may be balanced by the annual receipts. That this possibility is no remote one, will be apparent if we reflect on the place taken by the Leguminosæ among the wild plants and the field crops of India. Although some of the commonest—*e.g.*, the tamarind and the babul—do not belong to the group of "Nitrogen-gatherers," by far the greatest number of species of this vast Natural Order, including all our cultivated pulses, indigo, ground-nut, *sann*, fenugreek and lucerne, do so. **Soil Fertility.** *Conf. with p. 1.*

The following Note which the Editor has had the pleasure to receive from the Agricultural Chemist to the Government of India will be found to go over the same ground as that already reviewed by Professor Middleton. It, however, emphasizes certain points and in one or two instances conveys Dr. Leather's own peculiar views, so that it may be read as not altogether a repetition of the information already furnished:—

A Note on Plant Assimilation of Nitrogen, by* Dr. J. W. Leather, *Agricultural Chemist.*

Although it is well known that the source of the mineral food of plants is the soil, the exact source of the nitrogen, which they require, has **Mineral Food of Plants.**

* For papers giving greater details on this subject, see Lawe's Journal Royal Agricultural Society of England, (iii.) I., pages 69-86, and Lawes & Gilbert's Journal Royal Agricultural Society of England, III., pages 657-702; also Kropotkin, Nineteenth Century, August 1893, pages 259-366.

Nitrogen, Assimilation of,

Source of Nitrogen.

long been the subject of elaborate investigation and discussion. In this Note an attempt will be made to review very briefly the past history of this question and to show the position which it has assumed at the present time.

FREE NITROGEN.—It will be well in the first place to point out the distinction between the free nitrogen of the atmosphere and the *combined* nitrogen which exists both in the atmosphere and in the soil. About four-fifths of the atmosphere consist of this element, but in this case it exists as a gas in the free state and not combined with any other substance. In this condition it is a very *inert* substance, combining with difficulty and only under exceptional conditions with other elementary substances.

Ammonia. *Conf with p. 2.*

COMBINED NITROGEN.—But, in quite minute quantities, there are usually present in the atmosphere two compounds of nitrogen,—namely, ammonia (composed of nitrogen and hydrogen) and nitric acid (composed of nitrogen and oxygen), and in much larger quantity there are these same two compounds of nitrogen present in the soil.

In addition we find, in the soil and in large amounts, a very complex substance, named humous. This contains nitrogen in the *combined* state. Whilst the free nitrogen of the atmosphere is a very *inert* gas, these compounds of nitrogen are by no means so. They are indeed active substances which form a great variety of other and still more complex compounds. This definition refers in the first instance rather to the *chemical* than to the *physiological* properties of nitrogen. But just as, when in the *free* state it is chemically inert, so, when inhaled by animals, it takes no part in the changes which proceed in the lungs and is exhaled again without suffering change. *Combined* nitrogen, on the other hand, generally in the form of albuminoids, is a necessary food and takes part in the nourishment of animals, these compounds at the same time undergoing change. Thus so far as the higher animals are concerned, the terms *inert* and *active* hold good physiologically. The question whether they hold good in the case of vegetable physiology is not so simple.

Liebig, who made the subject of plant-food a special study, held that it was only necessary to add mineral food to the soil in order that plants should thrive luxuriantly, and that there was no necessity to apply nitrogenous manure since the plant acquires it independently.

Bertelot, Ville, and others studying the same question since Liebig's time came to the same conclusion. On the other hand, Lawes & Gilbert and Boussingault, after making most careful experiments, came to an opposite conclusion. The experiments of Lawes & Gilbert were performed in plants grown on *sterilized* soil and protected by a glass case from the nitric acid and ammonia which are always present in small quantities in the atmosphere. The result of four years' experiments was to show conclusively that plants when grown in sterilized soil had no power to assimilate the nitrogen of the atmosphere.

Nitrogenous Manures. *Conf. with p. 2.*

Other observations made with crops in the field taught some curious lessons. It was shown conclusively that the cereal crops were benefited, particularly by an application of a nitrogenous manure, that the root crops responded more especially to that of a phosphatic manure, whilst in the case of clover, which is a plant especially rich in nitrogen, the application of extra doses of that ingredient gave but a slight increase. And generally it seemed that plants require their food to be present in particular forms. Again, it was shown by Voelcker that if a crop of clover were grown, cut, and the hay removed, the surface soil was then actually richer in nitrogen than previously. The **Leguminosæ** indeed deported themselves throughout in a different manner to those of other orders. Although themselves so rich in nitrogen, they responded particularly to

the application of mineral manures, the phosphates and potash. Moreover, whilst other crops could be grown consecutively for long terms of years, on the same land, **Leguminosæ** failed, after a very short time, to respond to any manure, and, indeed, eventually refused to grow at all. Thus, then, without pursuing this subject farther, it was generally recognised that this order of plants possessed properties different from those of other natural orders, the members of which are included in our agricultural crops.

Phosphates and Potash.

In 1883 Hellriegel & Wilforth commenced a series of experiments on the subject of the direct assimilation of nitrogen by plants. These were instituted from a different standpoint to those which had been conducted by previous workers. Plants, both leguminous and non-leguminous, were grown in *sterilized* soil in separate pots. To some of these pots were added small quantities of nitrate, and it was found that most plants responded to its application; that where no nitrogen was added, the plants died down after using up their reserve material; whilst where it was added, they grew very much in a degree corresponding to the amount of nitrate added. Those of the leguminous order, however, did not so respond, or not to the same degree. In the next place these experiments added a small quantity of an aqueous extract of a fertile soil (containing only very minute quantities of nitrogen and other plant-food), with the result that some of the **Leguminosæ** at once commenced a vigorous growth. Other members of this order, however, did not respond to the application of this particular soil extract. Lupins, for instance, did not so respond. When, however, an aqueous extract of a soil, on which lupins were growing freely, was added to the sterilized soil, the lupins grew perfectly, and this behaviour was not dependent on the addition of nitrates, for provided the small quantity of the soil extract were given, these leguminous plants were apparently not dependent on additions of combined nitrogen.

Nitrate.

Conf. with p. 5.

Increase of Nitrogen.—Whilst, therefore, the growth of plants of other orders was dependent on a supply of *combined* nitrogen, and their growth was measurable within certain limits by the amount of nitrate added, the growth of the **Leguminosæ** appeared to be dependent on something else, and they grew luxuriantly with the aid of the addition of a little soil extract containing only very minute quantities of combined nitrogen. Lastly, *if the soil extract were sterilized* as well as the soil in the pots, they failed to grow. In the next place the amounts of nitrogen (small though they were) present in the sterilized sand, in the seed used, and in the soil extract, were determined. Also after these leguminous plants had been grown, the nitrogen was determined in the sand in the pots and in the whole plant. The total amounts of these quantities before and after the experiment were largely different; the final was indeed several times as great as the initial amount. Hellriegel & Wilforth's experiments have since been repeated by several workers on this interesting problem, and the result has been uniformly the same.

Increase of Nitrogen.

Root Tubercles.—Another matter must here be referred to. It was observed that the plants of this order, included in the various experiments, had peculiar nodular formations on their roots. What the exact relation of these is to the assimilation of free nitrogen has not yet been definitely explained. That there is some relation seems to be extremely probable, for where these plants have been grown in sterilized soil and without soil extract, no formation of nodules takes place. Then, too, it was found necessary in the case of certain leguminous plants, in order to successfully inoculate the sterilized soil, to add not an extract of *any* soil, but an extract of *some particular* soil,—such a one, indeed, as was

Tubercles.

Tubercles.

then supporting the particular plant in healthy growth; similarly, it had been noticed that the nodules on the different leguminous plants have characteristic forms peculiar to themselves. It is, however, unnecessary to pursue this subject farther.

These results do not necessarily contradict those obtained originally by Boussingault and by Lawes & Gilbert, who showed that plants, the **Leguminosæ** included, did not, when grown in *sterilized* soil, assimilate nitrogen from the air. Hellriegel's experiments indeed introduced an entirely novel feature into the question, namely, whether lower organisms do not in common with the **Leguminosæ** assimilate atmospheric nitrogen. It is this problem which has now, since the publication of the results of the experiments above described, been engaging the attention of a number of bacteriologists. They are still in progress, and although a great amount of time has been devoted to the subject, the matter is still but imperfectly understood.

Results.

PRACTICAL RESULTS.—The practical result of Hellriegel's and of Wilfarth's work is nevertheless clear,—namely, that whilst plants of most Natural Orders depend on combined nitrogen for their supplies of that element, the **Leguminosæ*** are not entirely so; and when plants of the leguminous order are grown in ordinary cultivated land, a gain of nitrogen to the soil is probably being effected. It is possible that the subject has an important relation to the economy of Indian agriculture. Dr. Voelcker in his recent report points out at page 46 how very plentiful are trees and plants of this order all over India, and the question naturally follows, "To what extent are these continually supplying nitrogen for the use of other crops?"

Peculiarities in the Distribution of Certain Indian Leguminosæ, by THE EDITOR.

[* So far as the reports, published by the biologists and chemists who have hitherto taken part in the investigations of the subject of plant assimilation of free nitrogen, are concerned, it would be less ambiguous to speak of the **Papilionaceæ** than the **Leguminosæ**. Dr. Voelcker, while making this reservation, adds—"No enquirer going over India could fail to be struck by the enormous preponderance of trees, crops, and even weeds that belong to the Natural Order **Leguminosæ**. Almost everywhere the babul **(Acacia arabica)** is seen with many other leguminous trees; gram **(Cicer arietinum)**, *arhar* **(Cajanus indicus)**, and numerous varieties of pulses, indigo, etc., are among the commonest crops, and are highly nitrogenous; lastly, leguminous shrubs and weeds abound, and are often spread on the land or ploughed in as manure. How can this be in a soil naturally poor in nitrogen?" The only tree mentioned by Dr. Voelcker (in the passage from which the above quotation has been taken) does not belong to the **Papilionaceæ**, while it is, as he very properly says, perhaps the most prevalent tree of the order in India; but its inclusion in a list of papilionaceous plants may be admitted as slightly misleading. On the other hand, there are many papilionaceous trees and bushes that are very prevalent, and which therefore belong to the group of **Leguminosæ** that has been demonstrated as form-

THE LEGUMINOSÆ.

ing tubercles on their roots. Of these may be mentioned the species of **Crotalaria, Indigofera, Tephrosia, Sesbania, Alhagi, Æschynomene, Uraria, Alysicarpus, Ougeinia, Desmodium, Mucuna, Erythrina, Spatholobus, Butea, Pueraria, Phaseolus, Vigna, Dolichos, Atylosia, Cajanus, Flemingia, Dalbergia, Pterocarpus, Pongamia, Derris,** etc. These and such like belong to the Sub-Order **Papilionaceæ.** Some of them are genera that embrace many species, and a few of the species, such as those of **Indigofera, Tephrosia, Alhagi, Spatholobus, Butea,** and **Flemingia,** are very gregarious, so that where met with at all they are often extremely plentiful. But with the exception of a few herbaceous forms of **Crotalaria, Indigofera, Tephrosia, Alysicarpus,** and **Desmodium,** practically none of the bushy or arborescent forms occur near cultivation, unless at the villages—a tree here and there. So also occasionally, especially along railway enclosures, **Dalbergia,** and **Pongamia,** are met with as avenue trees, but these rarely, if ever, exist on the village sites. Taking India as a whole, the system of growing hedges around the fields is not practised, but where hedges do occur they are mainly formed by the prickly species of **Acacia, Prosopis, Cæsalpinia, Parkinsonia,** etc., so far as the **Leguminosæ** are concerned, *and these are not* **Papilionaceæ.** If one were asked, therefore, to mention the most prevalent wild forms of **Leguminosæ,** that are found in association with cultivation, the answer would have to be the species of **Cassia,** and **Acacia,** neither of which belong to the group of plants that have hitherto been observed as participating in the process of nitrogen assimilation through the agency of root tubercles.

In Hedges.

But vast tracts of India exist in a state of scrubby jungle. The soil of such regions is of necessity very poor, otherwise much of it might long ere now have been brought under the plough. It is significant in such localities that, as a rule, the prevalent vegetation in point of number of individuals belongs to the **Papilionaceæ.** Witness, for example, the waste tracts of the Panjab and Rajputana, where **Alhagi,** is perhaps the most abundant plant. So, again, the rocky uplands of Chutia Nagpur and the Central Provinces, where trees, bushes, or herbs of **Butea, Spatholobus, Erythrina, Ougeinia, Flemingia, Smithia,** and **Abrus** occur every two or three yards over thousands of square miles of country, the more herbaceous species being often met with in great abundance. Witness also the still loftier mountain regions where species of **Indigofera, Desmodium, Vicia, Flemingia,** and **Vigna,** etc., dispute possession of the scanty soil.

In the Jungles.

In fact it would be difficult to think of an uncultivated region or forest tract where a very large percentage of the individual plants met with did not belong to the group of **Papilionaceæ.** And what is even still more significant, members of the **Mimoseæ** and **Cæsalpineæ** are, comparatively speaking, rare in such regions. Indeed, the contrast in this respect between wild tracts and the areas of cultivation is very great. Instead of the plants named, the Tamarind and the Babul dominate the village lands and the under-vegetation (so far as **Leguminosæ** is concerned) is mainly **Cassia,** with, on the mud

In the Cultivated Areas.

THE LEGUMINOSÆ

walls that separate the fields, a few papilionaceous herbaceous species such as **Desmodium, Alysicarpus,** or **Tephrosia,** and in the submerged fields of the lower provinces **Æschynomene.** But as weeds of cultivation there are remarkably few **Leguminosæ,** while the crops of that order belong to the **Papilionaceæ** entirely; and it is to these, and almost these exclusively, that the renovation of the soil's supply of nitrogen, through the agency of root tubercles, must be attributed, and not to the wild **Leguminosæ.** It is indeed noteworthy that there is no agricultural crop obtained from either the **Cæsalpineæ** or the **Mimoseæ.**

In Re-afforestration. *Conf. with p. 6.*

The part which the wild **Leguminosæ** play in preserving, if not in forming, the fertility of waste tracts is a question that should commend itself to the consideration of the Forest more than to that of the Agricultural Departments. If the views advanced by **Hellriegel** be confirmed, as applicable to all **Papilionaceæ,** then the inference would be unavoidable that in measures of re-afforestration a prominent place should be given to the encouragement of the growth of papilionaceous bushes or herbs, (in the initial stages of such experiments), even although these might be of no value as sources of timber.—G. W.]

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THE

AGRICULTURAL LEDGER.

1894—No. 17.

RICINUS COMMUNIS.

[*Dictionary of Economic Products, Vol. VI., Pt. I.*, F. R. 369–486.
Also Oils, Fats, and Oil-seeds, Vol. V. O. 50—110, and Oil-cakes, 118.]

REPORT ON THE CASTOR OILS IN THE INDIAN SECTION OF THE IMPERIAL INSTITUTE, LONDON.

Prepared by MR. W. H. DEERING, F.I.C., F.C.S., *Chief Assistant Chemist to H.M.'s War Department; and* MR. BOVERTON REDWOOD, F.R.S.E., *Experts on Oils.*

Samples examined.

FROM the collection of 78 castor oils in the Imperial Institute, we selected 23 for examination,—*viz.*, the five grades of Pirpainti oil (as representing the inland products), the same of Kotapatam oil (from coast seeds), a No. 1 and No. 2 and five No. 3 grades of inland oil other than Pirpainti, and six "good second" inland and coast oils (other than Pirpainti and Kotapatam).

Points ascertained

These oils have been examined as to their colour, specific gravity, viscosity, rotation of plane-polarised light, the amount of potash required to neutralise the free acid present in them and for their complete saponification, the amount of bromine which would combine with them, and their solubility in alcohol. The results are given in the subjoined table.

Manner of testing.

Viscosity.—This was determined by means of a Redwood viscosimeter.

Rotation of plane-polarised light.—A Hofmann-Laurent polarimeter was employed, D light, and 200 millimetres of oil.

RICINUS communis. **Report on the Castor Oils in the Indian**

Registered No.	Whence received.	Seed.	Colour.
1549	Oil merchant, Calcutta .	Var. Pirpainti, No. 1 .	Pale yellow . . . .
1550	,, ,, .	,, ,, No. 2 . .	Yellow, deeper than 1553 . .
1551	,, ,, .	,, ,, No. 3 .	Deep greenish yellow . .
1552	,, ,, .	,, ,, ordinary, No. 2.	,, ,, . .
1553	,, ,, .	,, ,, good second .	Pale yellow, deeper than 1549 .
3019	,, ,, .	Kotapatam, No. 1 . .	Pale yellow, like 1549 . .
3020	,, ,, .	,, good second .	Yellow, a little paler than 1560 .
3021	,, ,, .	,, No. 2 . .	Yellow, like 1560 . . .
3022	,, ,, .	,, No. 2, ordinary	Yellow, deeper than 3021, like 1550.
3023	,, ,, .	,, No. 3 . .	Deep brownish yellow, the deepest of the 23.
1554	,, ,, .	Kahlgaon, No. 1 . .	Rather pale yellow, a little deeper than 1553.
1560	,, ,, .	Makaya, No. 2 . .	Yellow, intermediate between 1550 and 1554.
1564	,, ,, .	Revelganj, No. 3 . .	Deep greenish yellow . .
1565	,, ,, .	Bamungama, No. 3 .	,, ,, . .
1566	,, ,, .	Rasulpur, No. 3 . .	,, ,, . .
1567	,, ,, .	Etawah, No. 3 . .	,, ,, . .
2754	,, ,, .	Patna, No. 3 . .	Deep yellow . . . .
2527	Madras Presidency . .	Masulipatam, good second	Rather pale yellow, like 1554 .
2531	Bengal	Midnapore, ,, ,, .	,, ,, ,, .
2535	,, ...	Baidyanath, ,, ,, .	,, ,, ,, .
2539	,, ...	Cuttack, ,, ,, .	,, ,, ,, .
2543	,, ...	Sahibganj, ,, ,, .	,, ,, ,, .
2745	Oil merchant, Calcutta .	Coconada, ,, ,, .	,, ,, ,, .
			Nos. 1549 and 1554 were very slightly turbid (opalescent); all the others were clear.

Section of the Imperial Institute. (*Deering and Redwood.*) **RICINUS communis.**

Specific gravity at 60° F.	Viscosity at 100° F. Seconds for 50 c.c.	Rotation of polarised light. 200 mm. oil.	Oleorefractometer reading.	Potash (KHO) required. For free acid.	Potash (KHO) required. Total for saponification.	Bromine absorbed.	Registered No.
				% KHO.	% KHO.	% Br.	
0·9637	1180	+8°·5	+42°	0·14	17·67	53·6	1549
0·9638	1184	+9°·0	+41°	0·53	17·73	53·5	1550
0·9637	1190	+9°·7	+41°	0·95	17·75	53·7	1551
0·9639	1179	+9°·5	+41°	1·03	17·85	53·5	1552
0·9641	1183	+8°·8	+42°	0·30	17·80	53·3	1553
0·9639	1177	+8°·6	+42°·5	0·17	17·94	52·9	3019
0·9640	1165	+8°·8	+42°·5	0·17	17·88	53·1	3020
0·9640	1173	+8°·5	+42°·5	0·18	17·84	52·8	3021
0·9638	1182	+8°·4	+42°·2	0·35	17·87	53·1	3022
0·9637	1179	+8°·7	+42°	0·74	17·80	53·0	3023
0·9640	1184	+7°·6	+42°·5	0·12	17·88	53·7	1554
0·9638	1186	+8°·7	+41°·5	0·54	17·86	53·2	1560
0·9639	1178	+9°·3	+41°	1·06	17·84	53·3	1564
0·9640	1184	about +9°·0	+41°	0·98	17·85	53·3	1565
0·9639	1182	+9°·4	+41°	1·00	17·82	53·1	1566
0·9640	1184	+9°·4	+41°	0·98	17·84	53·0	1567
0·9639	1170	+8°·4	+42°	0·38	17·89	52·9	2754
0·9642	1174	+8°·4	+42°	0·37	17·86	53·1	2527
0·9639	1185	+8°·6	+42°	0·38	17·90	53·1	2531
0·9641	1180	+8°·5	+41°	0·40	17·91	52·9	2535
0·9639	1160	+8°·6	+42°	0·37	17·91	53·1	2539
0·9640	1174	+8° 6	+41°·5	0·37	17·90	53·3	2543
0·9640	1185	+8°·6	+42°	0·35	17·86	53·3	2745

RICINUS communis. **Report on the Castor Oils in the Indian**

Bromine absorption.

Bromine absorption.—A solution of bromine in dry bisulphide of carbon was used, the oil being also dissolved in bisulphide of carbon. This was preferred to Von Hubl's iodine absorption method, in which a mixed reagent (iodine and mercuric chloride) and a mixed diluent (alcohol and chloroform) are used, and chlor-iodo products are formed; while in the bromine bisulphide of carbon method a more definite reagent is used, with formation of bromine addition products only.

Solubility.

Solubility in Alcohol.—One volume of oil was shaken up with three volumes of alcohol of specific gravity 0·830 (at 60°F.). All 23 oils were wholly soluble in the alcohol; they gave clear solutions which remained clear after standing for a couple of days.

The specific gravity, time of efflux (viscosity), amount of potash required for saponification, amount of bromine absorbed (also refractive index as indicated by the oleorefractometer reading), point to practical identity No. 1) contain of composition of the oils examined.

Constituents.

Triricinolein (the glyceride of which castor oil almost wholly consists) requires by calculation from the accepted formula 18·07% potash, and 51·47% bromine, the calculated amounts required by triolein, tristearin, tripalmitin (frequent constituents of oils and fats) are:—

		Potash required for saponification.	Bromine required to form saturated compound.
Triricinolein	$(C_{18}H_{33}O_3)3\cdot C_3H_5$	18·07% K H O	51·47% Br.
Tristearin	$(C_{18}H_{35}O_2)3\cdot C_3H_5$	18·92% ,,	...
Triolein	$(C_{18}H_{33}O_2)3\cdot C_3H_5$	19·05% ,,	54·26% ,,
Tripalmitin	$(C_{16}H_{31}O_2)3\cdot C_3H_5$	20·89% ,,	...

The estimation of the amount of bromine absorbed tends to be rather too high. The oils, as was to be expected, contain appreciable and varying amounts of free acid; the percentage of "potash required for free acid" × 5 gives the amount of free acid. The lower grades of oil contain more free acid than the higher ones; thus, the number one oils contain about 0·6% to 0·8%, most of the "good second" oils about 2%, most of the number three oils about 5% of free acid. The Kotapatam oils (except the No. 1) contain less free acid than the Pirpainti oils.

As a lubricant.

As lubricants, the oils examined should be equally good, judged by their viscosity (as indicated by times of efflux) alone, but the lower grades of oil would be likely to cause considerably greater corrosion of metal bearings, on account of their greater acidity.

Colour.

The depth of colour increases in proceeding from the higher to the lower grades of oil; colour has probably to a great extent been relied on in grading the oils.

Rotation.

The rotation of the plane of polarisation by castor oil is of scientific interest. The recorded observations are conflicting; thus, Fluckiger and Hanbury (Pharmacographia, p. 513) state that they found some samples of castor oil to be right, others left, rotating. Allen observed no rotation. Popp found specific rotatory power of castor oil, (a) $= +12°\cdot15$, but this was deduced from the rotation of 10 per cent. solutions of castor oil in alcohol, in which case errors of observation would be greatly multiplied up. Schadler gives the rotation of castor oil (apparently for 198 mm) as $+9°\cdot8$, but gives 0·9163 at 15° C. as the specific gravity of the oil, which, although probably a misprint, lessens confidence in the statement. The rotation caused by 200 mm. of castor oil under before-mentioned conditions was pretty nearly the same in all 23 oils; a right rotation of about 8°·5. The comparatively slight variations observed with so con-

siderable a number of castor oils of varying origin justify the belief that rotatory power is a property of the glyceride ricinolein, and not of impurities or unknown constituents of the oil; the amount of the latter must be small (castor oil gives about 96% of total fatty acids), and would need have a most unusually high rotatory power to produce the observed effect. The power (scarcely possessed at all by other natural glyceride oils) is probably connected with the fact that ricinoleic acid is an oxy-acid.

Manufacture of Turkey Red.

Turkey red oil.—Castor oil, as is well known, finds important application in Turkey-red dying, being converted into Turkey-red oil by the action of strong sulphuric acid, and subsequent neutralisation with alkali. From the general similarity in chemical composition of the oils examined, much difference in their behaviour with sulphuric acid was not anticipated; accordingly three oils, Nos. 1549, 2527, 1564 (a first, second and third grade oil, respectively) only were experimented with. The rise of temperature on stirring 50 grams of oil with 10 c.c. pure strong sulphuric acid (specific gravity 1·844 at 15° C.) was practically the same with the three oils, about 62° C., 63°, 61°, 60°·5 C., respectively.

A hundred grams of each of the three oils was treated with 33 grams of sulphuric acid, added in drops with constant stirring, the oil being cooled externally; the rise of temperature did not in any case exceed 17° C., and the evolution of sulphurous acid was very slight. The three products were left for a couple of days; they were then greenish-brown in colour, of treacly consistence, no appreciable difference between them in either respect. Each was then treated with 170 grams of water 40° C.; after separation of the water, the washed products were of light greenish-brown colour (No. 1549 lightest coloured. No. 2527 next lightest, No. 1564 darkest), and of the consistence of castor oil. They were then $\frac{4}{5}$ neutralised with caustic soda solution, then solution of ammonia added in moderate excess. All three gave clear liquids; No. 1549 was of golden-yellow colour, No. 2527 slightly browner, No. 1564 was the brownest, a brownish-yellow, or light yellowish-brown.

Purgative principle.

Purgative principle.—The purgative principle of castor oil has not yet been identified. Tuson's "ricinine" is stated by himself to be non-purgative. The greater part of the active principle appears to be left in the pressed seeds; its isolation and examination, and the estimation of the amount present in the oil and the press-cake, would be desirable.

W. H. DEERING.
BOVERTON REDWOOD.

18th September 1894.

(Vegetable Series, No. 14.)

THE

AGRICULTURAL LEDGER.

1894.—No. 20.

BORASSUS FLABELLIFORMIS, *Linn.*

[*Dictionary of Economic Products, Vol. I.*, B. 663—730.]

THE PALMYRA PALM;

ITS OCCURRENCE, CULTIVATION, AND USES.

Compiled by MR. EDGAR THURSTON *from reports furnished by the Forest Officers of India.*

General remarks.

THE following information was obtained as the result of a recent enquiry by Forest Officers, at the suggestion of the Inspector-General of Forests, with reference to the occurrence of the Palmyra palm, and the statement that in some districts the fibre at the junction of the leaves is less developed than in others, while in some localities it is entirely wanting.

GENERAL.

Habitat.

The Palmyra is not indigenous in India. It is said to have come from Africa (*Dict. Ec. Prod.*, Vol. I., p. 495), but the African species is not this, but B. Æthiopium, which occurs throughout dry tropical Africa, and is largely used for food. Outside the Indian Peninsula the Palmyra is found on the west, in the region of North-Eastern Arabia and along the shore of the Persian Gulf; on the east in Burma, the Malay Peninsula, and through Sumatra, Borneo, Celebes, and other islands, nearly, if not quite, as far as New Guinea. It is very common in the northern and north-eastern districts of Ceylon.

Occurrence in India.

In India it is found from Cape Comorin northward to Behar and the southern districts of the North-Western Provinces, and it is occasionally grown as far north as Rohilkhand and Saharanpur.

Madras.

In the Madras Presidency it is in common use for rafters of houses, well troughs and many other purposes, and is a most valuable and useful tree. It occurs in the greatest abundance on the eastern coast, especially in the Godavari, Kistna, and Nellore districts, in the latter of which there are patches of considerable size, which have been, or are to be, made into reserved forests. In Nellore a good tree is worth R1, but further inland, in the Ceded Districts, it sells from R2 to R2-8. It is largely grown in the hedges between fields, and is probably found valuable not only for its timber and as a fence, but as a protection against hot winds. It is very useful in reclaiming sandy wastes, and much good work in this direction has been done in the Cuddapah district on the banks of the Penner river and its tributaries, the Chitravati, Papagni, and Cheriyar. It can be planted, or rather sown, with the greatest ease, and grows well and quickly, if protected when young against goats and cattle.

Bombay.

In Bombay it is common in the Concan and Gujrat, but I can say little of its further distribution.

BORASSUS flabelliformis. **The Palmyra Palm :**

Bengal.

In Bengal it is found throughout the delta, but is most noticeably common in Behar, especially about Patna ; and from Behar it extends into Benares and Mirzapore, getting gradually less and less common northwards.—(*J. S. Gamble.*)

MADRAS.

MADRAS.

The following note on Palmyra in the Madras Presidency has been contributed by Mr. J. S. Gamble :—

Distribution.

" In the northern half of the Presidency the palm is rather unequally distributed. It prefers the flat lands along the coast on a somewhat sandy soil, and becomes gregarious on waste lands in suitable places. In the Ganjam and Vizagapatam districts it is not common, but is occasionally used as a hedge plant to mark the boundaries of fields and estates. In Godavari, where the delta soil is rich, it is not much found, for even outside the delta the lands are under cultivation where fit for it, and the waste lands are either hilly or are stretches of laterite down. But south of the Godavari it is more common, and especially in the Ellore taluq there is a great deal of it, chiefly in hedges or in groves on small patches of waste land. So, too, in the Kistna district, there is very little of it in the delta or in the inland taluqs, where the soil is unfavourable. But in the coast taluqs it is common enough both in hedges and in patches on waste land, and this is especially the case in the Bandar, Repalle, and Bapatta taluqs. In the Nellore district it is decidedly the most conspicuous and most common tree, especially near the coast. It may be seen universally used for hedge boundaries, and here and there it has so come up on waste land that it forms forests, some of which have been or are about to be reserved by the Forest Department. In Striharikota even there are many trees, and the right to tap most of these trees has had to be conceded at the forest settlement. It has also been planted to mark the forest boundary, and the plan of having a regular line of palms along such boundaries is an excellent one, as it makes them conspicuous and easily recognised.

" In the inland districts, the Palmyra is not so common, but wherever there is a suitable sandy soil it is easily planted. There is not much in Kurnool, nor in Anantapur, though in the latter district there are two reserves which chiefly contain it,—*viz.*, Khojjapalle and Anantapur. In Cuddapah, too, it is not common, except on the banks of the Rivers Penner, Chitravati, Papagni, and Cheyer, where it thrives on the brown sand and is most valuable for building and improving the soil.

" These are the districts which I know personally, but I believe I am correct in saying that it is much the same in the south. Along the coast in Chingleput, South Arcot, and Tanjore it is very common, as it is in Nellore ; while inland it is much less frequent, and confined to isolated trees, a few hedges, and patches of plantation along the rivers. It may be said that its real country is the coast strip down from the Kistna river to Cape Comorin.

Toddy.

" As regards its uses : everywhere it is tapped for *toddy*, and it is consequently an object of some solicitude to the officers of the Abkari Department. The tapping, unlike that of the date palm, does not injure the tree, for it only requires the cutting away of a few leaves and the gradual slicing of the flowering branch which yields the sap. The *fruit* is an article of food, when somewhat green, for they contain at that time a soft, transparent, jelly-like albumen. The young *seedlings* are also eaten as a vegetable and are commonly sold in the bazaars. The *leaves* are used for thatching and for fuel, and in some parts of the country, as in Nellore, they are almost the chief fuel used by the people. The *timber* is in universal employ for building purposes. The stems are split in two to four pieces, the inner soft part cut away, and the rest forms excellent rafters not only for native houses, but for European bungalows. In Nellore a tree used to sell for ₹1, while in Anantapur, where it is more scarce, the price was ₹2-8. The tree trunks are also used universally for the poles and lever of the common apparatus of well-work : a solid trunk forms the upright, rafters or bamboos form a ladder, while long rafter-pieces weighted at one end with a large stone or log of hard wood form the lever on which the labourer walks to raise or depress the end which bears the rope and water bag or wooden bucket. Water *buckets* are often made from the root end of the tree hollowed out, and are, I believe, very strong and durable. The outer part of the wood is very hard and almost indestructible, white ants will never touch it. As

Fruit. Seedlings.

Leaves. Timber.

Price.

Apparatus for raising water.

Buckets.

MADRAS. Fibre.

regards the *fibre*, I have never seen it collected or used; but I am sure there would be no difficulty in doing so, for it is very common. I should think that it would be easy to use it for brush-making with a little preparation.

Cultivation.

"The Palmyra tree is very easily cultivated: the only thing that has to be done is to collect and sow the seeds, which germinate readily, and to protect the young seedlings from cattle, and from villagers who collect them and use them as a vegetable. On the banks of the Penner, in the Jammakmadugu taluq principally, excellent work was done by Mr. A. W. Higgens in endeavouring to stop the drifting sand by planting Palmyra and big grasses, principally, I think, Saccharum ciliare, itself a valuable fibre-yielder. I believe that a large extension of this work, which can be done very cheaply, is much to be desired, and I think that the results in preventing the widening of the sandy tracts along the river and the damage to cultivation by blown sand would alone repay the expense, without counting the value of the produce in toddy, leaf fuel, fibre, and timber."

Use as a sand-binder.

Fibre for brush-making.

The following information, a portion of which has already been published in the Imperial Institute Hand-book, "Fibres for brush-making," was obtained through an enquiry set on foot by the Board of Revenue:—

1. Nellore District.

Nellore.

Samples of fibre, prepared by the District Forest Officer, were submitted to the Inspector-General of Ordnance, who reported that the fibre appeared good, and suitable for brush-making.

2. North Arcot District.

North Arcot.

It is reported that a very large quantity of fibre can be procured annually.

3. Chingleput District.

Chingleput.

Palmyra fibre is brought into Madras from this district, where the palm is abundant. The supply is obtained chiefly from Kovoor, Kunnathur, and Poonamallee of Saidapet taluq, and from Tinnanur, Avadi, and Tiruvur of Tiruvallur taluq. The fibre received as above is in a very rough state, and requires considerable treatment before it is fit for use.

Palmyra fibre for brush-making is said to be imported from Ceylon, as the fibre produced locally is not suited for the purpose.

4. South Arcot District.

South Arcot.

Rope-making

Brush-making.

The Collector of South Arcot forwarded samples of Palmyra fibre which is extracted in some of the taluqs, where palmyra is abundantly found, and which is utilised solely for *rope-making*. Some fit for brush-making purposes could, the Collector believed, be extracted in fairly large quantities in Tiruvannamalai, Cuddalore, Villupuram, and Vriddhachalam taluqs. The process of extracting is very primitive. The stalks are soaked in water for a day and then taken out, partially dried in the shade, and beaten with a wooden mallet until the fibre is separated from the pithy husk sticking to it. The fibre thus taken out may be also oiled with lamp oil, by which it becomes stronger and less stiff. The cost of preparing a pound of fibre by this process is three annas. Of the samples sent, two were extracted from palmyra stocks, one being oiled and the other not oiled; the third contained fibre prepared out of the sheathing of the petioles and peduncles of palmyra called in Tamil *pannadai*, and the fourth contained the mid-ribs of palmyra leaves. The Inspector-General of Ordnance, who tested the samples as to their suitability for brush-making, reported that sample No. 1 could be used in the trade in lieu of the "Piasabu" or "Bass," fibres which are largely used. The sample was considered suitable for use in the manufacture of gun-brushes in the Ordnance Department in lieu of Piasabu.

BORASSUS flabelliformis. **The Palmyra Palm :**

MADRAS. Brush-making.

Of the other samples, Nos. 2 and 3, he believed, might be found suitable for brush-making in the trade, as they would probably answer for light hand-brooms, etc. : but sample No. 4 appeared too soft and elastic. The Inspector-General of Ordnance was of opinion that the fibres might be improved by selection and treatment, and suggested that expert opinion might be obtained on this head from South America and other parts where such fibres are largely extracted.

5. Salem District.

Salem.

The following information relative to the preparation of Palmyra fibre as carried out in the Salem district was supplied by the District Forest Officer :—

Period of cutting the leaves.

Outer fibre.

Inner fibre.

The fibre is obtained from the stalks of the leaves, which are usually taken from the tree soon after the toddy-drawing season. The leaf-stalks, when in a green state, are beaten with a wooden mallet on a flat granite slab. The surface or outer fibres are then separated, and reserved for making strong ropes. The inner fibres, well separated from the non-fibrous tissue by being rubbed between the hands, are combed with a wooden comb or beaten on the ground, and are then ready to be worked up into ropes or to be used in the raw state for binding the roofs of thatched houses. It appears that the maximum yield of leaves from one tree in a year is ten, and that the ten leaf-stalks will produce about 1 lb of fibre, which it would take a man or woman a whole day to prepare. Thus the average yield of fibre per tree per annum may be set down at from ½ to ¾ of a pound. This, however, is not a district, like Tanjore and Tinnevelly, in which palmyras are numerous. Doubtless if a foreign demand for the fibre were to spring up at a price somewhat higher than the local cost of production, which is about 2½ annas per lb, a considerable quantity might be available for export.

Yield.

6. Madura District.

Madura.

Palmyra fibre is exported to Ceylon from Pámban, a town on Rámesvaram Island. The following information as to the trade in, and method of preparation of, the fibre was obtained from a report by the Head Assistant Collector :—

Objection to a new industry.

Pámban is the only place in this division in which the trade is carried on at all. Its existence there seems to be largely due to the efforts of the agent of a firm in Colombo who has been actively engaged in encouraging the natives of the island to prepare and sell to him the fibre. It is with great difficulty that he can induce the people to undertake an industry that is new to them and was not practised by their forefathers, and in many instances instruction in the method of preparing the fibre and even advances of money to be repaid in fibre were not productive of much extension of the trade. Were it not for this difficulty, the quantity available in this division would be very large, as the Palmyra trees grow in great numbers everywhere. This might, however, be surmounted if instruction as to the method of preparation of the fibre and information as to the high price it fetches were sufficiently disseminated. The present price in Pámban Island is Rs 10 a hundredweight.

Method of Preparation.

The method of preparation simply consists in detaching from the trunk of the palmyra tree the lower part of the stalk of the leaf which remains clinging to the tree after the leaf has been cut off or died, beating this with a wooden hammer, and pulling out the fibre which is so detached. The best trees for the purpose are young ones from 12 to 15 feet high, as in these there are usually more of these leaf-stalks attached to the trunk. They fall off as the tree gets older. The stalks require to be in a certain or particular state of decay, in which the fibre in them when hammered out will be of a black colour. The white fibre which is obtained from immature stalks is less pliable and more brittle, and fetches an inferior price in the market.

The Deputy Collector, Melur Division, reported that fibre suitable for brush-making could be obtained from Rámnád, Tiruvdanai, Mudukolatur, Sivagunga, and Pámban.

Its Occurrence, Cultivation, and Uses. (*E. Thurston.*) **BORASSUS flabelliformis.**

MADRAS. Expert's opinion.

The fibre exported to Ceylon was submitted to the Inspector-General of Ordnance, who reported that "the sample is not suitable for the manufacture of gun-brushes, being too pliable and weak. It is, however, the best sample of palmyra fibre yet submitted by District Officers, and probably it might be suitable for ordinary brush-making."

7. Tinnevelly District.

Tinnevelly.

The following information was supplied by the Collector :—

Palmyra fibre is exported from the ports of Kayalpatnam, Kulasekharapatnam, and Tuticorin to London and Colombo for brush-making. Two or three European firms at Tuticorin are engaged in the trade. It is reported that about 400 cwts. of the fibre were exported in August last from Kayalpatnam; and that from January 1891 to December 1892, 441 cwts. of fibre for brush-making and rope-making were exported from Kulasekharapatnam. The fibre is said to be worth ₹19 or ₹20 per cwt., but no accurate data are available. The export trade in the fibre is yet in its infancy, and the prospects of its development are believed to be satisfactory.

Value.

Samples of fibre were submitted to the Inspector-General of Ordnance, who reported that about two thirds appeared good, and suitable for brush-making.

BOMBAY.

BOMBAY.

1. Northern Circle.

Northern Circle.

Mr. F. R. Dasai, the Deputy Conservator of Forests, Northern Circle, writes :—

"The palm prevails to a large extent in the Thana district, but in the other districts—*viz.*, Surat and Panch Mahals—it is not common. The fibre produced by the tree at the junction of the leaves is reported to be fairly well developed wherever the tree is met with, but, so far as it can be ascertained, it is not used by the people of the district except for burning."

2. Southern Circle.

Southern Circle.

Mr. MacGregor, the Conservator of Forests, Southern Circle, states that "South of Kolaba it is very rare, but it is sporadically met with in the talukas below the ghats as far south as Kanara. The Divisional Officer of Kolaba reports that the trees in the Alibag range have no fibres at the junction of the leaves. The fibre and fruit do not appear to be utilised by any one, but the leaves are used in the manufacture of fans, rain-protectors, thatch, and the sap in that of sugar. The tree is too scattered and scarce ever to form an important trade produce unless planted on a large scale. The situation of the districts close to the coast, notably that of the hottest parts of the Kolaba district, appears to be well suited to the growth of the tree."

3. Central Circle and Sind.

Central Circle.

The palm is reported to be very rare in both the Central Circle and Sind.

BENGAL.

BENGAL.

Mr. R. L. Heinig reports that—

Eastern Districts.

The Palmyra palm is fairly plentiful in the Khulna and Backergunge districts (Sundarban Division). It is cultivated in association with the Cocoanut, Areca-nut palms, etc., chiefly for the sake of the stems, which are used as water-pipes; toddy is obtained from the peduncles; the fruit is eaten; and the leaves are occasionally used

BORASSUS flabelliformis. **The Palmyra Palm :**

BENGAL. Fibre.

in thatching. The fibre obtained from the sheathing base of the petiole is not used in any quantity. It is not durable, nor has it a market value. In the rainy season, when the rice-fields are flooded, the villagers used the fibre to fasten the framework of small baskets employed to catch fish at the sluices of the fields.

N.-W. PROVINCES.

NORTH-WESTERN PROVINCES AND OUDH.

1. Central Circle.

Mr. C. Bagshawe writes :—

Central Circle.

"The Palmyra palm is not found in the forests of this circle between the Sarda and Ganges. It is found in Bundelkhand, but is rare, and was probably introduced for ornamental purposes.

"With regard to the fibre at the junction of the leaves, the Extra Assistant Conservator, Bundelkhand, writes :—'The fibre at the junction of the leaves is present in local specimens; but I hear that it is less developed in Gorakhpur (Oudh), where the palm is common, and the fibre used for rough brushes.'

"The palm has not been specially noticed in Jhansi and elsewhere."

2. Oudh Circle.

Mr. S. Eardley Wilmot has communicated the following note :—

Oudh Circle.

"The Palmyra palm does not occur indigenously in the forests. It is cultivated to a considerable extent in the district of Gorakhpur, where it attains a height of 50 feet, though trees 10 feet high are often tapped. The few specimens examined had the fibre fully developed at the junction of the leaves. The yearly revenue from a mature tree is about ₹2 or ₹3. The wood is strong, but the tree is retained for the manufacture of *tari*."

CENTRAL PROVINCES.

CENTRAL PROVINCES.

1. Southern Circle.

Mr. A. E. Lowrie writes :—

Southern Circle.

"The Palmyra palm is fairly common in the Chanda district, both inside and outside forest limits, but is chiefly confined to the edges of tracts that are or have been under cultivation. The northern limit of this palm here is a line drawn from Chanda to Garchiroli across the Wain Ganga river. From here northward the date-palm takes the place of the palmyra.

Season of flowering.

"The soil best suited to the growth of this palm is a light sandy soil, but it can grow very well in black soil and in laterite. It cannot, however, stand very much drought, and prefers rather a damp locality to a dry one. In the beginning of February the flowers appear somewhat earlier in the male than in the female plant. In June the fruit ripens and falls, generally during the night owing to the numerous 'Lesser Fruit Bats,' which frequent the trees to suck the sweet, stringy pulp. The seed, which is very hard when the fruit is ripe, is thrown away, and germinates freely. In out-of-the-way places most of the seed germinates where the fruit falls, and forms dense thickets similar to what one sees in Northern India with the date-palm.

Fibre. Process of shedding leaves.

"In this district the fibre produced at the junction of the leaves is well developed. From sections made it appears that, on the fibre leaving the leaf at its junction with the stem, it runs into it at an angle of about 45°, the central fibres of the petiole running down at times to a depth of 2 inches before spreading down the stem. Some fibres were traced for over 2 feet along the stem. Judging from the older stems, it would appear that the fibre was wanting at the junction of the leaves, but this is simply due to the fact that, as the stem increases, the petiole gets split up. This split keeps on increasing until the two portions of the split petiole are not sufficient to support the heavy leaf at the end of it, and consequently the whole leaf falls along the stem, and, in so

doing, snaps the connection of the fibres at the junction of the petiole with the stem. The leaf then begins to dry, and falls eventually to the ground, leaving a scar on the face of the stem, which makes it appear that the leaf was deciduous without the fibres being continuous." CENTRAL PROVINCES.

2. Northern Circle.

According to Mr. R. Thomson—

The palm occurs very sparingly in some districts, and is absent in others. Wherever observed, the fibres produced at the base of the leaf were always found to be present. Northern Circle.

BERAR. BERAR.

Mr. C. Bagshawe has furnished the following particulars regarding the palmyra as such within this province:—

1. Ellichpur.

The palm is rarely met with.

2. Amraoti.

Some palms were found in Babulbans, and the leaves cut at their insertion with the stem, to ascertain the development of the fibre. The number of bundles counted in six palms 4″ square on the cross-section was 54, 60, 63, 54, and 70, respectively. Number of fibres in petiole.

3. Akola and Basi.

The palm is rare.

4. Buldana.

There is scarcely a palm. Green leaves were examined, and no developed fibres found.

BURMA. BURMA.

The following notes have been communicated by the officers mentioned regarding the palm as met with in Burma:—

Northern Circle.

1. Plentiful. Lower Chindwin, Minbu, and Yaw forest divisions. It is cultivated in all villages of the plains, where there are sometimes groves of two or three square miles in extent. It thrives best on low, dry land, and in the dry, sandy belts on both sides of the Irrawaddy. It is planted, but must reproduce itself naturally, since the seeds that drop from the trees appear to germinate freely. Northern Circle.

2. Rare. Upper Chindwin forest division, where, it is stated, only 500 trees are registered for toddy.

The fibre is reported not to develop to any great extent anywhere. It is not used locally at all in the Upper or Lower Chindwin divisions. In the Pakokku township, Yaw division, the fibre is used for making small ropes or twine, such as is required for jungle-fowl snares, but not for stouter ropes; so it is supposed the fibre cannot be very well developed. In the wilder parts of the division it is not used at all, the people preferring the bast fibre **Sterculia sp.** Fibre.

In the Minbu division it is stated that the fibre at the root of the leaves is not developed till the palm is 15 or 20 years old, and that then it is found in all trees. It is said to be used for making brushes only in Minbu.—(*A. L. Home.*)

2. Pegu Circle.

The Palmyra palm may be said to be plentiful in the Prome district, common in the Thayetmyo, Tharrawaddy, Hanthawaddy, Pegu, Toungoo, and Henzada districts, and rare in the Shwegyin, Bassein, and Thongwa districts. Pegu Circle.

All trees in the Pegu circle are regarded as private property, the owners paying a tax to Government on the number of trees they possess. The fibre produced at the junction of the leaves is never absent, and nothing can be discovered as to whether it is more fully developed in one district than another. In one locality in Tharrawaddy, however, the natives state that the fibre is more plentiful in the case of trees which have not been tapped for toddy.—(*P. J. Carter.*)

BORASSUS flabelliformis. **The Palmyra Palm :**

BURMA.

TENASSERIM.

The Palmyra palm is found in a cultivated condition in most parts of this circle. In some of the remote forests it now grows wild, but may have been originally cultivated. The Karens say that it is really wild-growing, and that the two forms—cultivated and wild—are different.

Fibre. The fibre does not apparently vary according to locality. It was always present in specimens examined, which were taken from many localities.—(*C. T. Bingham.*)

EASTERN CIRCLE.

The Palmyra palm is cultivated in all divisions to a small extent near villages. It is nowhere very abundant except in parts of the Yen, Sagaing, Mandalay, Kyeukse, and Meiktila districts, where the tree is grown largely for the manufacture of jaggery. The tree only occurs to any extent in tracts which Forest Officers have no occasion to visit, and consequently they have not been able to give any information in regard to the fibre.—(*J. W. Oliver.*)

Other Provinces. The Palmyra palm is reported not to exist in the forest division of Assam, Baluchistan, the Punjab, Ajmere, Coorg, and the Andamans.

EDGAR THURSTON,
Superintendent, Central Museum, Madras.

NOTE BY THE EDITOR.

Note by the Editor. The Palmyra palm is found in most parts of India, chiefly in Madras, Bombay, Bengal, and Burma, but in the major portion of its distribution it might be described as inserted between the areas of the more marine loving cocoa-nut and the more alpine date-palm.

Occurrence and use. Almost every part of the plant is put to some economic use. The wood forms a valuable rafter for houses. In Central Bengal its use as such has rather diminished of late owing to brick buildings with teak-wood beams and rafters taking the place of the mud houses for which the palmyra timber was in demand. The palm (as also the cocoa-nut and date palms) owes its value chiefly to the sweet juice which it yields, and which on fermentation is transformed into an intoxicating liquor, called Toddy or *Tari*. Muhammadans, who are prohibited by religion to take wines and spirits, do not consider that the injunction extends to palm wines, and their cheapness has made them favourite intoxicants with the poorer classes. In Burma, and Madras sugar is made from the unfermented juice. Fans are constructed of the young leaves. South of Calcutta, very young leaves are woven into braids and an export trade in these has recently been created. Baskets, hats, and other articles are also made of the leaves. From time immemorial they have served in the East the purposes of writing-paper. In Orissa and the Madras Presidency they are still used as a note-paper for writing letters and sometimes even for more valuable documents, such as leases of land. The three large stones within the fruit are covered with a thick growth of fibre and inside the fibrous shell with a pomatum-like yellow pulp, which is sweet in taste. This is eaten raw, or is hardened into thin slabs by the admixture of a little lime,

or fried into cakes after being mixed with flour, sugar, and cocoa-nut scrapings. The cabbage or terminal bud is also eaten. In Gujrat, the seedlings are eaten cooked as a vegetable or made into pickles. The germinating embryo within the stone is also considered a delicacy, and in some places it is reduced to flour.

For further particulars of this palm, see the Dictionary article quoted above.

The present enquiry is mainly with regard to a fibre contained in the long peduncles of the leaves, which is considered suitable for brush-making. In India, however, it is not put to much use, except in making a rough kind of rope or in tying together bamboo sticks to form fishing-cages. Samples of this fibre were lately sent to the Imperial Institute, London. They were examined by Mr. C. E. Collyer, an expert on fibrous substances, whose report is given below :—

The fibre expert's opinion.

REPORT AND VALUATION OF PALMYRA FIBRE ON SAMPLES RECEIVED FROM THE INDIAN SECTION OF THE IMPERIAL INSTITUTE.

By C. E. COLLYER.

The stiff fibre extracted from the base or sheath of the leaf-stalk, when in mature condition, of dark colour, and tough and supple in quality, is in considerable favour as a broom and brush making material, and has rapidly become one of the best substitutes for Bahia Piassava, notwithstanding a tendency to curl in warm and dry weather.

The consumption has kept pace with the supply, and its use could be largely increased if sufficient quantities could be obtained at moderate prices, of which according to the available information there is much doubt.

The light-coloured fibre extracted from the leaf-stalk itself is of a different character, and is at present of comparatively small value;—its want of life, toughness, and strength to recover its straightness after being bent, limit its use to common mixing purposes, and it is considered inferior to African Piassava for the lowest uses. It is possible a better and more extensive use for this fibre may ultimately be found, but in the meantime shipments would come to a very doubtful market.

BORASSUS flabelliformis. **The Palmyra Palm:**

Fibre.

Detailed valuations are given in the following statement:—

REPORT ON PALMYRA FIBRES.

No.	Name.	Whence received.	Length.	Description.	Value.
1756-92 .	Borassus flabelliformis.	Tinnevelly, Madras.	...	Part of the "outer sheath" or leaf-stalk, cut very short, mixed, strong, stiff, and short soft fibre in combination; the stiff fibre when extracted would be suitable for brushes, and the soft fibre for curling or hair purposes. The sample as sent is valueless, but if sent of full size would be saleable at about .	Nominal £10 per ton if of full size.
1692-92 .	Ditto .	North Arcot, Madras.	...	From interior of stem; sample very rough; the fibre has lost its strength and quality, and is useless in present condition	*Nil.*
1691-92 .	Ditto .	Ditto .	20"—24"	From leaf-stalk; tender pithy fibre, light yellow colour; only partially cleaned; of small value for mixing purposes	£14
2371-93 .	Ditto .	Ditto .	9"—20"	Mature from leaf-stalk; well cleaned, mostly good colour, rather too fine, and some too soft; would sell readily.	£34—35
2372-93 .	Ditto .	Ditto .	12"—20"	Fine, taken from the sheath; light brown colour; soft fine fibre; clean. These light-coloured fibres have not yet any definite position in the market, but are likely to come into use for some purposes, mixing, etc. .	£24—25
2367-93 .	Ditto .	Madura district, Madras.	8"—18"	Good brown colour; mostly good stiff clean fibre; some short and some only partly cleaned and pithy. Practically any quantity of this quality can be sold at current prices; present value .	£35—37
546-92 .	Ditto .	Tinnevelly, Madras.	12"—18"	From the leaf-stalk; badly cleaned; soft pithy fibre; tender; part light, part dull brown colour, for mixing .	£15—18

Its Occurrence, Cultivation, and Uses. (*C. E. Collyer.*) **BORASSUS flabelliformis.**

No.	Name.	Whence received.	Length.	Description.	Value.
2369-93 .	Borassus flabelliformis.	Tinnevelly, Madras.	8″—13″	From the leaf-sheath; mostly well cleaned, good dark colour, rather fine and short; would sell in any quantity; at current rates, present value	£33
105-92 .	Ditto .	Indian Museum, Calcutta.	10″—12″	From inside of wood; tender; soft and poor, fairly clean; doubtful sale . . .	£10—12
1103-91 .	Ditto .	Ditto .	14″—22″	From leaf-stalk; bright yellow colour; wanting in toughness and springback; would probably sell for mixing, well cleaned, about	£18
				N.B.—It is probable that if the "sheath" from the same trees were tried it would yield the stiff dark fibre required by the trade similar to 2369-93. By the sheath is meant that part of the leaf-stalk that grips the trunk of the tree, not the *outer* sheath as No. 1756-92. This "sheath" is said to yield the best fibre two years after the leaf has fallen, and to be most prolific on the comparatively young trees.	

Fibre.

C. E. Collyer.

141, Fenchurch Street, London;
18th September 1893.

Mr. Collyer is right as regards his remarks about the supply. Were a large demand to develop, it is doubtful whether India could participate to any great extent. The palm takes a long time to reach maturity, but leaves can be had for the extraction of fibre after five or six years.—[G. W.]

The following note on the use of *Dantalá* (*i.e.*, the tender root which the seeds send down at the time of germinating), as a vegetable in Gujarat, has been supplied by Mr. J. W. Mollison, Officiating Director, Department of Land Records and Agriculture, Bombay :— The tap-root.

The fruit of the palmyra palm is, as food, of as much importance as the vegetable (*Dantalá*, Guj.) obtained from the young seedling. Each

BORASSUS flabelliformis. **The Palmyra Palm; its occurrence, etc.**

The tap-root.

fruit contains two or three kernels. The fruits are plucked before they are ripe if the kernels (*galalis*, Guj.) are to be eaten raw. The *galalis* are sold raw at 12 for one anna when good, or say 6 fruits per anna. They are ripe enough for eating in April. The fruits are dead ripe in June and then fall from the trees. Fallen fruits are useful only for planting out the nursery in which the *Dantalá* vegetable grows, or for propagating the palmyra palm in the natural way. The vegetable succeeds best if the nursery is well prepared before plantation and if the soil is *Goradu, i.e.*, a deep light loam. The *Dantalá* is spindle-shaped, 9 to 12 inches long, and 1 to 1½ inches in diameter at the thick end.

The seedlings are grown as crowded as possible in the nursery, and for this reason the *Dantalá* grows abnormally and contains much more food material than would be the case if the fruits were planted singly at considerable distances apart. The method of cultivation is simple. The fallen fruits are collected in June-July and laid close together on the surface of a previously prepared seed-bed and are then lightly covered with soil. No manure is given. About four months after plantation the *Dantalá* is ready for digging. If left longer, the starchy nutrient material stored disappears in the formation of leaves and in the natural growth of the young seedling.

The *Dantalás* are found deeply imbedded in the soil. They are dug out with an ordinary native hand pick, the soil being moved to a depth of 15 to 18 inches. This operation is therefore costly. The vegetable is roasted before it is offered for sale. It is eaten chiefly by Kolis and low-caste people. Neither it nor the fruit of the palmyra palm is eaten by high-caste Hindus.

The *Dantalás* are this year worth about 16 per anna. The kernels of the fruit used for raw eating are dearer than *Dantalás*, chiefly because only the superior, well developed fruits yield the former, and considerable expense is incurred in climbing the trees to get them.

The *Dantalá* cultivation is, as far as I know in this presidency, confined to the neighbourhood of Surat and to the market gardens along the sea-coast at Bassein near Bombay. In the latter tract the soil is of considerable depth and sandy to a degree, whilst near Surat the most suitable soil is old Bhatta, *i.e.*, fine, loamy soil deposited at one time as silt by the Tapti and still liable to inundation, but only in years at very high flood.

The *Dantalá* cultivation in this presidency is important, because of the enormous value of outturn per acre, and because it might be economically imitated elsewhere in India. It is unimportant in the sense that the actual area cultivated is inconsiderable. Nurseries are seldom larger than $\frac{1}{20}$th to $\frac{1}{10}$th of an acre each. In a nursery about 50 palmyra palm fruits are planted in a square yard, and these may produce 100 *Dantalás* or more, and the gross value of yield, per acre, will be, at ordinary market rates, ₹1,800. If the vegetable is dear, the outturn per acre may be worth ₹3,000.

I cannot venture to give an estimate of the cost of cultivation. There is no doubt that if any cultivator, having a large plantation of palmyra palms, collects and plants all fallen fruit, the revenue per acre from *Dantalás* must be enormous; but then the fruits at an earlier stage had probably an equal market value.

B. 663—730.

G. I. C. P. O.—No. 883 R. A.—8-7-95.—2,000.—DES.

(Implements and Machinery Series, No. 3.)

THE

AGRICULTURAL LEDGER.

1895—No. 23.

DAIRY FARMING AND DAIRY PRODUCE:

THE INDIAN CHURN.

[*Dictionary of Economic Products, Vol. III.*, D. 14 a.]

A Précis of Official Correspondence on the Indian Churn—by the EDITOR.

Enquiry made by Herr B. Martiny.

In a letter addressed to the Government of India Herr B. Martiny, of Berlin, asked for information regarding the Indian Churn. He there announces that he is engaged writing a history of the Churn and is desirous of obtaining certain particulars regarding "the old Indian Churn" of which he furnished a drawing. The Government of India directed the writer to circulate Herr Martiny's letter and drawing, to all Local Governments and Administrations (through the Agricultural Departments), for such information as they were in a position to afford. The replies since received may be said to embrace the whole of India and to furnish many interesting particulars that, it is believed, may be found of practical value. With that idea in view the present paper has, therefore, been prepared for publication in the Ledger, and it may be described as a review that follows closely on the lines of the original communications.

It may not be out of place to explain here that the writer felt, when he issued Herr Martiny's original communication, that the object aimed at might, perhaps, have been more effectually secured by the removal of the restriction to the scope of the enquiry implied by any assumption that the particular churn figured by Herr Martiny was of necessity "the old Indian Churn" or rather the oldest Indian contrivance for making butter. The replies fix the area over which that particular churn is found, but as this may be said to be practically the whole of India, the enquiry has lost in some cases the advantage of being a complete account of all the known churns of the provinces of India. In other words, the replies are only too frequently confined to definitely affirming that the churn figured is the one in most general use. Moreover, the expression "the old Indian Churn" practically implies that there is a newer one in use, which of course is not the case.

At the same time the reference to the "Malayan population" has for the most part been read literally, with the result that we have not been furnished with the information desired, namely, particulars regarding the cruder methods of preparing butter that are pursued by the aboriginal tribes and poor communities of the less frequented regions of India.

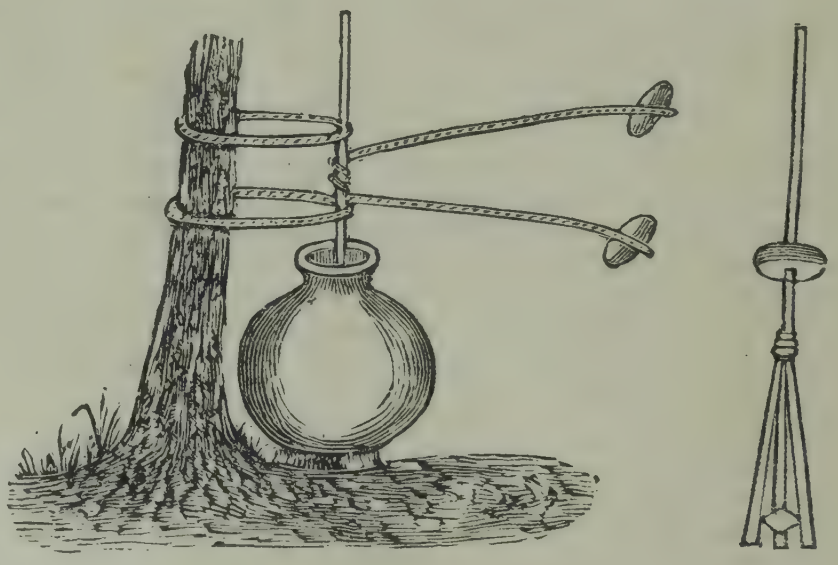
Herr Martiny's Questions.

It may help the reader to more fully understand the remarks which follow if the set of questions asked by **Herr Martiny** be given here, since in most cases the communications that have been received in reply are more or less categorical :—

1. In what provinces is the old Indian churn still in use?
2. Are the people in these provinces of Aryan or of Malayan types?
3. What is the name of the churn?
4. I presume that this old Indian churn is the churn of the Aryan population; if I am right, what kind of churn is then used by the Malayan population?
5. Philarator says the Indian churn, containing 30 to 35 gallons, is used by different people, who bring their milk sometimes many miles to the churn; what is the reason for doing so; why has not every cow-holder his own though of course smaller churn?
6. Is there any other primitive churn in use in India or any other old fashion of making butter, *i.e.*, making butter in a bowl by a whirl without using a string or by shaking (beating) the milk only with the bare hand, or shaking it in a skin-bag like the Arabs and the Baluchis do?

The "Old Indian Churn."

The following may be given as a reproduction of **Herr Martiny's** drawing of the instrument he characterises as "the old Indian churn" and which he apparently thinks may have originated with the Aryan people:—



Early methods of churning milk.

It seems probable that the more primitive methods of preparing butter, which prevail among the aboriginal tribes to the present day, existed all over India long anterior to the introduction of the more elaborate system by means of "the old Indian churn." The discovery that milk yielded a solid fatty substance, butter, when agitated in a bamboo joint (*Chonga*) or in any other vessel, and further that this deposition was facilitated by the milk being beaten up with the hand, may be p resumed as co-equal in point of time with the discovery of the method of procuring milk and of its value as an article of human food. It is hardly conceivable that there should have been any great

interval between the two discoveries, since in the warmer parts of India at least, the difficulty of preserving milk or of carrying it to any distance must have been as great in remote antiquity as it is to-day. Methods of preserving milk and of preparing from it special articles of human diet, that would wholly or partially withstand these climatic tendencies, must have early become axioms of household economy. But in the consequent development of this knowledge it would seem that the introduction within the liquid, about to be manipulated, of a contrivance intended to more fully effect the object attained by the hand, would be a natural and simple one, and one which might fairly well have suggested itself spontaneously to the most diverse races. Whether or not the Aryans introduced that particular form of churn that is now very generally used throughout India, may be left as a question for the Ethnologist to solve. But what can be affirmed from actual knowledge of the people of to-day is that the principle of that churn is known and practised all over the country by people of admitted Aryan origin no doubt, but very largely also by those of non-Aryan descent. And among the non-Aryan races the names given to the churn and to its various parts would appear to be quite independent of the corresponding names derivable from the classic language of the early invaders of India.

Use of churn in ancient times.

The following may be given as an abstract of the chief replies that have been given to **Herr Martiny's** set of questions—grouped, for convenience, province by province. The figures sometimes given within brackets denote the number of the question to which the remarks are intended to be a reply:—

BENGAL.

I.—BENGAL.—Mr. N. N. Banerjee, Assistant to the Director of Land Records and Agriculture, writes that (1) "The old Indian Churn" is in general use throughout the Lower Provinces, which are peopled (2) by races of Aryan type. The earthen vessel (3) in which the churning is done is called *hara* or *harí* and the churning-stick *mahuna*, but these names, he says, doubtless differ in various tracts, such as in Behar, Orissa, Darjiling, etc. (4) It is the Aryan Churn. It may be mentioned that the hillmen of Darjiling employ a bamboo cylinder;* the Dravidians or Negretic tribes, such as the Kols of Chota-Nagpur, may possibly use a different kind of churn. (5) Every *gwálá* or cowherd has his churn. (6) With the exception of the bamboo cylinder above referred to, there are no other primitive churns known.

The vessel in which the butter is churned, which may be slightly modified in size and shape in the various districts of the province, is usually of earthenware—rarely of metal. The bamboo churning-stick shown is likewise very general throughout Lower Bengal. In Cuttack and other places, however, instead of a split bamboo, it is a solid piece of wood with the lower portion in the shape of a fluted cylinder. In Darjiling butter is made by shaking milk in small bamboo cylinders.

Subsequent to the receipt of the above communication, a further letter was obtained from the office of the Director of Land Records and Agriculture which gave, in the following tabular form, an abstract statement of all the replies that had been received from the District Officers of Bengal:—

* The Bhutias use a bamboo and a piston with a circular piece of wood at the further end having four notches cut into it. The motion is vertical up and down instead of rotatory.—*Editor.*

BENGAL.

Analytical Statement of the replies from certain Districts of Bengal

	1	2	3
Name of District from which information was obtained.	Is the old Indian churn as given in the sketch appended to Herr Martiny's letter used in the District? If not, what other kinds of churns are in use?	Are ths *Gwálás* of the District of the Aryan or Malayan type?	What is the local vernacular name of the churn used in the District?
Darjiling.	The churning apparatus used on the hills consists of a wooden vessel and a wooden churning-stick. The churns used by the Bhutias, Lepchas and Nepalese are all made of wood and are similar in construction. The Bhutias also churn butter in a bamboo cylinder by means of a wooden churning-stick.	The Nepalese are the original inhabitants of Nepal. The Brahmans, Chhattris and some Newars amongst the Nepalese are said to be of the Aryan type. The Bhutias and Lepchas are of Chinese and Malayan types.	The churn is called *Theki* by the Nepalese and *kewdong* and *keokedong* by the Bhutias and Lepchas (*i.e.*, the aboriginals of Darjiling including Kalimpong, Sikkim and Bhutan).
Mymensingh	The old Indian churn given in the illustration is in use almost throughout Bengal. It is known for certain that it is used in the districts of Dacca, Faridpur, Jessore, Birbhum and Mymensingh. It is said to be used also in the several districts of Behar and Orissa.	Aryan . .	The name is *Charkhi* in Bengali and Hindustani. In Persian it is called *Cherkh*. The local name among the *gwálás* of this district is *Sitkali*.

* This is clearly a misconception, as the concluding sentence shows, and due mainly churned, but sell their surplus milk to traders who churn all the milk so purchased in selling milk instead of butter has its origin also in the religious prejudice that would

arranged under the headings of Herr Martiny's *questions.* BENGAL.

4	5	6	
Is the old Indian churn given in the sketch the churn of the Aryan population? If so, what kind of churn is used by the Malayan population?	It is stated that the Indian churn containing 30 to 35 gallons is used by different people, who bring their milk sometimes many miles to the churn. What is the reason for doing so? Why has not every cow-holder his own, of course, smaller churn?	Is there any other primitive churn in use in India, or any other old fashion of making butter; *i.e.*, making butter in a bowl by a whirl without using a string or by shaking (beating) the milk only with the bare hand or shaking it in a skin-bag like the Arabians and the Baluchis?	
.....	The *Theki* holds milk from 10 seers to 20 seers and the *kew-dong* or *keo-kedong* holds milk from 5 seers to 20 seers. Each cow-holder has got a churning apparatus for his own use.	The Lepchas often make butter by shaking the milk in bamboo *chongas*—a method easier for working with small quantities of milk. The Nepalese sometimes put cream into a plate and shake it with their hands till butter is formed. Servants in the employ of private gentlemen in making butter invariably put cream and little milk in a bottle and shake it till the butter is formed. The natives also prepare butter sometimes in this fashion.	Darjiling.
Yes, the churn is that of the Aryan population. As regards the kind of churn used by the Malayan population there is no positive information available; but a gentleman who has been to Chittagong and has moved among the *Magh* population who certainly belong to the Malayan type, states that he has seen the *Maghs* using churns of the kind given in the illustration.	In this district milk is brought from a long distance to the churn* and this is the case with the professional milkmen who buy milk in the village and bring it for the purpose to their lodgings at some central place. Milk is brought in very large vessels containing from 1 to 2 maunds in each vessel. Among the cultivators they have of course their own churns of smaller size for their own domestic use.	It is stated that butter is sometimes prepared by shaking the milk with the bare hand, but this can be done only wher the milk is small and butter required for domestic purposes in a family.	Mymensingh.

to the way in which question 6 was put. The milkmen do not carry their milk to be larger churns than the milkmen possess or require for their own use. The practice of prevent certain people from eating butter not churned by themselves.—*Ed.*

BENGAL. *Analytical Statement of the replies from certain Districts of Bengal*

	1	2	3
Name of District from which information was obtained.	Is the old Indian churn as given in the sketch appended to Herr Martiny's letter used in the District? If not, what other kinds of churns are in use?	Are the *Gwálás* of the District of the Aryan or Malayan type?	What is the local vernacular name of the churn used in the District?
Noakhali .	The churn in use in this district is the same as the one shewn in the illustration attached to Herr Martiny's letter with this modification that generally two strings, instead of one, are attached to the churning rod and two persons from opposite sides pull it which keeps it in position and the post to which the rod is tied is dispensed with.	The milkmen here who are known as *Gopís* are of the Aryan extraction and originally came from Dacca and Chittagong and settled here. It is not known what kind of churn is used by the Malayan population.	The churn is known by the term *Mathan* which is the Bengali form of the Sanskrit word *Manthan* from root *Mantha* to churn.
Chittagong Hill Tracts.	The *Gwálás* here use the same churn as sketched in Herr Martiny's letter.	.....	.....

arranged under the headings of Herr Martiny's *questions*—continued. BENGAL.

4	5	6	
Is the old Indian churn given in the sketch the churn of the Aryan population? If so, what kind of churn is used by the Malayan population?	It is stated that the Indian churn containing 30 to 35 gallons is used by different people, who bring their milk sometimes many miles to the churn. What is the reason for doing so? Why has not every cow-holder his own, of course smaller, churn?	Is there any other primitive churn in use in India, or any other old fashion of making butter; *i.e.*, making butter in a bowl by a whirl without using a string or by shaking (beating) the milk only with the bare hand or shaking it in a skin-bag like the Arabians and the Baluchis?	
.....	The cow-owners of this district being generally Muhammadans keep no churns of their own to prepare butter. The curd prepared by them would not find a sale among the Hindus. They find it, therefore, more profitable to sell milk to the Hindus who do the work of churning. This is also an instance of the Indian mode of division of labour or profit. Those who tend cattle do not take the trouble of keeping an establishment for converting milk into butter. They leave this to another class whose sole profession is the extraction of butter and preparation of curd from milk.	The householders in this district have a simple mode of extracting butter from the cream of milk. The cream is put into a bowl with some water; it is then shaken and whirled by the bare hand.	Noakhali.
.....	.....	.....	Chittagong Hill Tracts

BENGAL.

Analytical Statement of the replies from certain Districts of Bengal

	1	2	3
Name of District from which information was obtained.	Is the old Indian churn as given in the sketch appended to Herr Martiny's letter used in the District? If not, what other kind of churns are in use?	Are the *Gwálás* of the District of the Aryan or Malayan type?	What is the local vernacular name of the churn used in the District?
Gaya .	The form of churn shown in the illustration of Herr Martiny's letter is that commonly in use in this district.	Aryan . .	*Matmahni* is the most descriptive word, *Mat* meaning the earthen vessel and *Mahni* the stick used for churning. The earthen vessels used are commonly called *Matka* when small and *Bhauri* when big.
Purnea .	The old Indian churn as shown in Herr Martiny's engraving is the only kind in use in this district.	The people that use the churn here are Aryans.	*Ghirni* . .

arranged under the headings of Herr Martiny's *questions*—continued. BENGAL.

4	5	6	
Is the old Indian churn given in the sketch the churn of the Aryan population? If so, what kind of churn is used by the Malayan population?	It is stated that the Indian churn containing 30 to 35 gallons is used by different people, who bring their milk sometimes many miles to the churn. What is the reason for doing so? Why has not every cow-holder his own, of course smaller, churn?	Is there any other primitive churn in use in India, or any other old fashion of making butter; *i.e.*, making butter in a bowl by a whirl without using a string or by shaking (beating) the milk only with the bare hand or shaking it in a skin-bag like the Arabians and the Baluchis?	
The churn is that of the Aryans; there are no Malayans known here.	The churns are of all sizes; nearly every one in the country manufactures his own butter, even if only a quarter seer, in a tiny earthen pot stirred with a bit of split stick. The *Gwálás*, however, who keep cows to manufacture butter and curd for sale in the bazar, use churns which will turn out as much as a maund at a time. It is not the custom for persons who have cows to take their milk to another person's churn. Every cow-owner has the necessary materials for a churn and makes his own butter.	People who have only small quantities to make often prepare the butter by chafing the milk between their hands inside the earthen vessel instead of using a *Mahni* which would be suitable for a small quantity. Butter is not prepared in any of the other ways mentioned, in the villages, but the servants of Europeans and of some residents of big towns prepare it by shaking the milk in a bottle. But this custom is not indigenous.	Gaya.
This churn is used only by the Aryans.	Almost every *Gwálá*, *i.e.*, a man who keeps cows for selling milk and butter, has his own *Ghirni*, so people have no occasion to bring their milk many miles to the churn.	There is no other primitive churn in use in this District, though butter is sometimes made by shaking up milk in a bottle.	Purnea.

BENGAL. *Analytical Statement of the replies from certain Districts of Bengal*

	1	2	3
Name of District from which information was obtained.	Is the old Indian churn as given in the sketch appended to Herr Martiny's letter used in the District? If not, what other kinds of churns are in use?	Are the *Gwálás* of the District of the Aryan or Malayan type?	What is the local vernacular name of the churn used in the District?
Sonthal Parganas (Pakur subdivision).	The old Indian churn as shown in the illustration is in use here.	Both Aryans and aborigines are to be found in this district.	Higher castes of Bengalis call the churning-stick the *Manthan danda* or *Mathni*. The lower class of Hindus call it *chatka*. In Sonthali the name is *Mondhaini*. For large quantities of milk, the earthen vessels used are locally called *jálás*, and smaller earthern pots are called *handis*.
Cuttack .	Every *Gwálá* churns his milk in a churn like the sketch appended to Herr Martiny's letter, but the vessel in which the milk is churned is but an earthen pot, a common *kalsi* or *handi* in which a bamboo or wooden whisk (called "*Khna*") is worked round by means of a piece of cloth or rope. If the quantity of milk is small the churn is worked between the palms of the hand.	..	...

arranged under the headings of Herr Martiny's *questions*—concluded. **BENGAL.**

4	5	6	
Is the old Indian churn given in the sketch the churn of the Aryan population? If so, what kind of churn is used by the Malayan population?	It is stated that the Indian churn containing 30 to 35 gallons is used by different people, who bring their milk sometimes many miles to the churn. What is the reason for doing so? Why has not every cow-holder his own, of course smaller, churn?	Is there any other primitive churn in use in India, or any other old fashion of making butter; *i.e.*, making butter in a bowl by a whirl without using a string or by shaking (beating) the milk only with the bare hand or shaking it in a skin-bag like the Arabians and the Baluchis?	
...	All owners of cows have their own churn.	When a small quantity for home consumption is required, it is occasionally made by beating the milk only with the bare hand.	**Sonthal Parganas.**
...	Every man has his own churning apparatus in this district.	Sometimes milk is shaken in a bottle with the object of producing butter.	**Cuttack.**

BENGAL.

Behar.—Mr. G A. Grierson (Behar *Peasant Life*) gives some interesting particulars regarding the names given to the churn in Behar. It is *mahal* to the west of the province, *mahab* to the south and east. The act of churning is *mahāi* or *mathāi* with the following local variants: *mahi* in Champāran and South Bhagalpur, *mathai* or *mahan* in Gaya. On the north of the Ganges and to the west a churn is *matmahni*. In Tirhut and Gaya it is *kúnra*, *kúnda* and *khor*. South of the Ganges it is *kamārí* (in South-West Shahabad), *taula* in the rest of the district, *ghormāha* north of the Ganges and *mahanra* in South Monghyr.

The stick moved in the churn bears the following names in various parts of the province: *rahi* (generally) *mahni* to the west, but in Tirhut there are many variants such as *mathni*, *mahan*, *mahonni*. Other local names are *gajhi*, *chhorhi* and *ghorathi*.

ASSAM.

II. ASSAM.—Mr. E. A. Gait, Director, Department of Land Records and Agriculture, reports:—(1) The old Indian churn is in use in Sylhet, Cachar, and Goalpara, the districts inhabited by Bengalis, and also in the Assam Valley. In the latter, however, its use is almost exclusively confined to foreigners, chiefly Bengalis and Nepalese. The churn is very little used by the indigenous Assamese, and not at all by the Manipuris, or the Mongolian tribes of the hill districts which divide the valley of Surma from that of the Brahmaputra. The Mongolian tribes never consume milk. (3) In Sylhet where Bengali is spoken the common term for churn is *mathan* or *mathankurá*. In the Jaintia Parganas it is called *Jhupráná* or *Har máthuni*. Other Bengali terms are *Ghágri*, *Besáli*, *Miti*, *Kharen* and *Buem*. The churn staff is called *Khurá*. The Nepalese name for the churn is said to be *Dhongra*. (5) The reason why in some parts each person does not possess his own churn is because the preparation of butter, etc., forms the distinctive occupation of special caste of the people—the *Goalas*. In this Province, however, it is customary for each person to have his own churn. (6) When only a small quantity of butter is wanted, it is made either by using a whirl without a string, or else by stirring the milk with the bare hand.

N.-W. P.

III.—NORTH-WEST PROVINCES AND OUDH.—The information supplied by Mr. Keventer, Dairy Expert, to the Director of Land Records and Agriculture, may be here given. (1) The old Indian churn is used in these Provinces and (2) by Aryan races. (3) The local name for it is *Mathani*; the beater or churn-stick is known as the *Rey*. The former is made of unglazed earthenware and the latter of wood or bamboo. (5) No churn seen by me contains more than 1 maund (about 8 gallons), and the custom of bringing milk for miles to the churn is not known in these Provinces. Nearly every villager who keeps buffaloes or cows has his own churn, which, complete, costs 6 to 10 annas. (6) Native ladies churn small quantities of milk by simply twirling the *rey* (dasher) between their hands, without the aid of any rope. Milkmen by trade generally use a churn, in which the beater is worked by two men.

Although very simple and inexpensive, the Indian churn is effective, and if properly used does not leave much unformed butter in the milk. The action of the *rey* much resembles the action of the dasher (*die Tlugel*) in the Holstein Churn.

Bundelkhand.—The Political Agent reports: (1) The old Indian churn is still used in the State (2) by Aryan races; (3) it is called *Matka*

or *Matkia*, and is oftenest made of earthenware, when of brass or copper it is called *Deg*. (4) There is no Malayan race in this part of India. (5) Every cowherd has his own churn, and (6) no other kind of churn is used.

CENTRAL PROVINCES.

IV. CENTRAL PROVINCES.—From these provinces certain samples of "the old Indian churn" have been furnished by the Commissioner of Settlements and Agriculture. Of these one is said to be used in making butter from curds, the others from milk. In a further communication the Commissioner regrets his inability to reply to Herr B. Martiny's questions regarding the history of the Indian churn and peculiarities in its use.

PANJAB.

V. PANJAB.—Replies received through Mr. F. A. Robertson, the Director of Land Records and Agriculture:—(1) The old Indian churn is still in use in the districts of Ferozepore, Montgomery, Kangra, Rohtak, Gujranwala, Amritsar, Hissar, Hoshiarpur, and Peshawar; (2) which districts are populated by Aryan types. (3) The native term for churn is *Madhani*. But in the Rohtak and Hissar districts, it is known as *Rai* or *Jhirna*. (4) The kind of churn used by Malayan races is not known. (5) Every cow-owner and nearly every householder has his own churn. Large *Madhanis* or public churns for the use of different families are nowhere met with. A notable exception, however, exists in the Indian churn containing 30—35 gallons, and even more, which is used by the nomadic tribes of the Panjab Bar. This churn is worked by two men standing opposite. In the Rohtak and Hissar Districts of the Panjab, two kinds of churns are used, the larger called *Rai* for quantities above 2 seers, the other called *Jhirna* for smaller quantities. (6) The other primitive churns in use in the Panjab are (*a*) skin-bags for making butter, used in the Kullu subdivision of the Kangra District. The *Bosis* and *Gaddis* of this Division obtain butter by shaking the milk in skin-bags by means of strings attached to the bags which are suspended from the roof of the house or from the branches of a tree. In the Gujranwala and Hoshiarpur Districts butter is occasionally made by beating the coagulated milk with the bare hand. In Amritsar, again, cream butter is made by shaking the cream in a bottle, but this is confined mostly to European households.

CENTRAL INDIA.

VI. CENTRAL INDIA.—The following brief notes may be accepted as representing the information conveyed by the extensive correspondence that ensued between the offices of Reporter on Economic Products and those of the various States in the Agency:—

Indore.

Indore.—Replies received from the Minister to His Highness the Maharaja Holkar, G.C.S.I.

(1) The churn is a household institution in every part of the State and consists of a vessel (metallic, wooden, or earthen), a churning rod and rope. The shape, quality and size of the churn vary according to requirements and means of the household. (2) All the inhabitants of the State are of Aryan type. (3) The churning vessel is called *Charvi* and the churning rod *Ravi*. (4) The kind of churn used by Malayan races is not known. (5) Every household uses its own churn. Churns for the common use of more than one household are not known in this State. (6) The practice of obtaining butter in any other way than by the old Indian churn is unknown. A skin-bag has never been known for churning purposes in a Hindu household; its use would be looked upon as a pollution. In very small churns the churning rod is sometimes worked by the hand alone, but this is rarely the case.

CENTRAL INDIA. Gwalior.

Gwalior.—Information received from the Director of Land Records, Gwalior :—

(1) The old Indian churn is still in use throughout this territory (2) which is populated by Aryan races. (3) The vernacular terms for the vessel are *Dudhandi*, *Mahaindi*, and *Matki*, the wooden stick or whisk is known as *Mathani* or *Rai*. (5) Each householder keeps his own churn. The practice of keeping one churn for public use is not known.

Bhopal.

Bhopal.—Information obtained through the Bhopal Agency :—(1) The old Indian churn is used. (2) The inhabitants are of the Aryan family. (3) The churn is variously known as *Rae* and *Arai*. (5) Every one uses his own churn. The practice of bringing milk to one large churn is not known. (6) No other method of obtaining butter is adopted.

Western Malwa.—The Political Agent reports :—

(1) The common churn is used. (2) The population in this district are mostly Aryan. (3) The churn is known by the name of the churning staff called *Raí* or *Bilonĩ*. (4) In this district, every cow-holder has his own churn. There are no large churns as described in the question. (6) No other primitive churn is used. When, however, the milk is small in quantity the churning staff is twirled between the palms of the hands, and the rope or string is dispensed with. Shaking milk in a bottle is a modern fashion adopted by Europeans only.

Goona.

Goona.—The Political Assistant forwards the following replies received from the Native States in the Agency :—

(3) Name of churn *Arai* or *Mathani*. (5) Every holder of cows has his own churn.

Baghelkhand.—The Political Agent reports :—

(1) The old Indian churn is still in use in the Native States of the Baghelkhand Agency. (2) The people are of Aryan type. (3) The churn is called *Mathani*. (5) There is no Dairy Farm here. Every cow-holder has his own churn.

Bhopawar.

Bhopawar.—The Political Agent reports :—

(1) The old Indian churn is the only kind in use (3) The earthen pot (metal vessels are rarely used) is called *Mathni*, and the churn-staff is known as *Rai*. The latter is of wood or bamboo or both and varies somewhat in shape. (5) A large churn holds about 30lb of milk. It is not the custom to bring milk to one churn from different places.

Dewas.

Dewas State.—The Superintendent of the Senior Branch reports :—

(1) The churn figured is still in use in this State. (2) With exception of a few Bhíls, the people are of the Aryan type. (3) In Hindi, the language of the country, the churning-rod is called *Rowai*. The earthen vessel is called *Matki* or *Matka*; sometimes the vessel is of metal, when it is called *Charwi*, *Batloi*, *Hunda*, etc. (4) The old Indian churn is that used by the Aryan people. There are no Malayan races in the State. (5) Every cow-holder has his own churn, and the custom of bringing curds from a long distance to be churned is not known. (6) No other form of churn is used. When the quantity of milk to be churned is very small, a churning-staff of smaller size is used, and butter obtained by simply twirling it between the hands.

The Karbhari of the Junior Branch reports :—

(1) The old Indian churn is still in use. (2) The inhabitants are of the Aryan type with also Bhíls. (3) The name of the vessel if made of clay is in the Rangdi dialect *Máth*, *Gola*, and *Máthána*, and in Marathi *Math*. If of metal, which is seldom used, it is called, in Rangdi, *Handá*, and *Charvá* or *Charví* if small. Occasionally the vessel is of

CENTRAL INDIA.

slightly different shape, when it is called *Baltoi*. If of the shape of a round jar, it is called *Math*, or *Derá*. The churning-rod is invariably made of wood and is called variously in Rangdi—*Ravi*, *Ravai*, *Raváya*, *Biloni*, *Khelar*, *Khelan*, *Mathniya*. In Marathi it is called *Ravi* only. (4) This is the churn of the Aryan population. That used by the Bhíls and other aboriginal tribes is the same as the old Indian churn. (5) Every cow-holder has his own churn, large or small as his requirements may be, and the custom of bringing milk from a long distance to be churned is not known. (6) No other primitive churn is used. Butter is sometimes made by shaking the milk in a vessel with the bare hand.

BOMBAY.

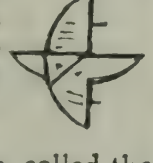
VII.—RAJPUTÁNÁ: Jaipur.

The Rev. John Traill of Jaipur furnished the following information regarding the churn in use in Rajputáná :—

The old Indian churn is universally used in Rajputáná, which is inhabited both by the Aryan and the non-Aryan races:—*e.g.*, the Bhils and others. The names of the parts do not, even among the Bhíls, differ much from those used elsewhere.

(1) The dish containing the milk to be churned is called the *Ghará*, *Hándi*, *Biláuná*, or *Golí*. It is the common earthen pot, made by the village potter. Metal or wooden dishes are not used, because they are not so easily cleaned and they are apt to give a bad taste to the milk and butter. The milk before churning is called *Dáhí* and after, *Chách*. The butter before clarifying is called *Lúní* and after, *Ghí*.

(2) The churning staff or whisk is commonly made of bamboo, because it is light, strong, easily split up to make the whisk and does not give a bad taste to the milk. It is called *Dándá*, *Jherá*, and by the Bhíls *Ravai* and *Rai*. When bamboo cannot be easily got other wood, such as the root of the *Bábúl*, is used. The staff from the lower end is split up, for about a foot, into four parts, which are thinned a little and called the four *Tárí*. The ends of these are let into the four arms of the *Phúl*, to beat the milk. A knot in the bamboo, or an iron ring (*Kharí*, *Bagrí*) keeps the bamboo from splitting up further than necessary.



(3) To whirl the churning staff very rapidly, a thin rope, called the *Netrá*, *Netro* (Bhíl), is coiled three or four times round the *dándá*. The *Koilí* is a round piece of wood, three or four inches long, let into the end of the rope, to prevent the butter-maker's hands from slipping.

(4) To keep the milk from rising out of the *Golí*, a lid or *dákhná* rests on the top of the *handí*. It does not turn with the *dándá*.

(5) The churning is commonly done by one person. To keep the staff erect in the *handí*, a post, a small tree or pillar or a wall is used as a support (*thámbá*). Two rope rings (*Senkhá*) are fastened to the wall by nails or put round the post or tree, and above and below the *netrá* hold the staff. They are wide enough to let the staff revolve freely.

Each *Gosi* (cow-holder) has his own churn, the size of which is modified by the quantity of milk. Except in the case of those who buy up surplus milk I never heard of people churning more than the milk of their own cows. I know of only one modification of the above:—A *small* whisk (*dándá*) is twirled between the hands, and not by a rope, among milk, in a small *handí*, till butter is formed. This is not often done. I have also seen butter made in a bottle by the servants in Europeans' houses. Proper bottles cannot be got by the *Gosís* and only a small quantity can be made in this way, and so this is not one of the regular ways of making butter in Rajputáná.

The word "old" in the name given by Herr Martiny to the Indian churn cannot mean that there is a new one in use. It will be long before the present one is superseded. It can only mean that the old Indian churn is so old that no one knows when it was first made.

BOMBAY.

VIII. BOMBAY.—The following interesting notes on the subject of the churns in use in the Western Presidency have been communicated by **Mr. E. C. Ozanne**, Survey Commissioner and Director of Land Records and Agriculture. It will be observed that **Mr. Mollison's** note, forwarded by **Mr. Ozanne**, deals with the practical consideration of the method pursued and the results obtained by the Native churn.

Mr. Ozanne writes:—

(1) The churn as illustrated in Herr B. Martiny's letter No. 1 of 28th December 1893 represents the common churn of this Presidency. The churns vary in size with the quantity of milk. *Gavlis* (professional milkmen) employ large churns which are usually narrow-mouthed earthenware pots. The shape and construction of the beater varies. One like that illustrated by Herr B. Martiny is used in the Konkan. It differs from the illustration only in having no disc on the handle. It consists of a piece of bamboo, forked out at one end into four segments. The beater in common use throughout this Presidency (except in Gujarat) has a wooden handle on which a head-piece of iron or hard wood is fitted. The head-piece is cast or cut into a series of flanges, which are well calculated to agitate the contents of the churn thoroughly during the churning process. This beater as well as the Konkan beater are adjusted for work in precisely the manner shown in Herr B. Martiny's illustration. Each is worked by one woman. The Gujarati churn is different. In order to illustrate it, I send a diagram which shows the manner in which the beater is set in the churn and adjusted for work. Two women are required to work it, one on either side.

(2) The churns above referred to are used by people of Aryan origin. I can give no information as to the kind of churn used by people of Malayan origin.

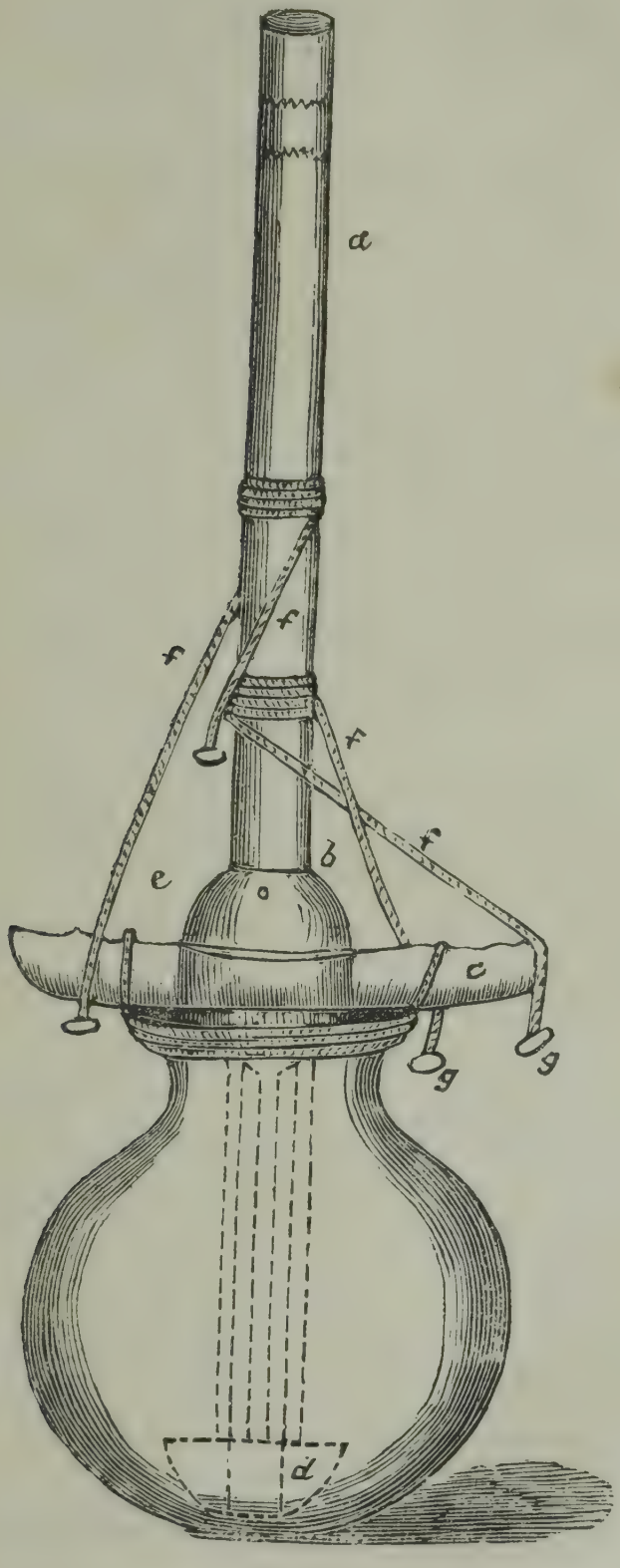
(3) Every owner of milch cattle has a churn, small or large, according to requirements. Householders, who do not keep milch cattle, often own a churn and make butter from bought milk. The butter is usually made daily, and if the quantity required is small a miniature beater is used and is whirled between the palms of the hands without the aid of a rope.

In the households of Europeans, resident in India, butlers make fresh butter each morning by shaking cream mixed with a little water or milk in a bottle, or by using an egg-beater to agitate the diluted cream in an open bowl.

(4) The native churn as a whole has no distinctive vernacular name. The essential parts are named as follows in Maráthi, Gujaráti, and Kanarese:—

English.	Maráthi.	Gujaráti.	Kanarese.
Churn vessel . .	Máthan .	Goli . .	Majjigi mádo bhándi.
Beater . . .	Ravi . .	Ravai . .	Kadagolu.
Shaft of beater . .	Dánda . .	Dándo .	Kolu.
Head-piece of beater .	Mathli . .	Phul . .	Mandi.
Support ropes . .	Mánjari .	Not used .	Katto hagga.
Rope which works the shaft.	Ánsani, bárdi, ravidor.	Netara . .	Kado hagga.
Post against which churn is supported.	Ghusalkhámb, Tákmadh.	Not used .	Kado Khamba.
Collar on shaft of beater	Not used .	Ládvo .	Not used.
Cross piece, which rests upon and is tied to mouth of churn.	Not used .	Háth . .	Not used.

Gujarati Churn



Gujaráti names of parts.

a=Dándo.

b=Ládvo.

c=Háth.

d=Phul.

e=Dori.

f=Netara.

g=Adolis.

h=Goli.

BOMBAY.

D. 14 a.

BOMBAY.

Description of the Gujarati Churn.

"The main shaft (*a*) (Dándo) is a piece of bamboo. Its lower end is slit up to a joint into four segments. Each segment fits into a cross head-piece (*d*) (*Phul*). These slits together with the *Phul* cause violent agitation of the curd, when the main shaft is made to revolve by means of the ropes (*ff*) (*Netara*). To work the churn, two people are required, one on either side. The collar (*b*) (*Ládvo*) is fixed to the *Dándo* by means of a wooden pin (as shown in diagram). If the pin is withdrawn, the collar can be made to move up or down on the main shaft, on that the beater can be adjusted to fit any size of churn. The *Phul* (*d*) must be just clear of the bottom of the vessel. The main shaft also passes through the cross-piece (*c*) (*Háth*). The *Háth* is securely lashed to the rim of the vessel (*h*) (*Goli*) by a thin rope (*e*) (*Dori*). The notches on the under-surface of the *Háth* fit on to the rim of the vessel, whilst the notches on the upper surface prevent the rope from slipping or slackening; hence the lashing is quite secure."

Note by **Mr. J. W. Mollison**, Superintendent of Farms, Bombay, on the process of making butter in a native churn :—

"Butter is made from the curd of whole milk. The milk whilst quite fresh is well boiled and then cooled. Whilst still warm, a little sour whey is added. The milk curdles and the curd is kept for at least 12 hours before it is churned. When ready for churning, it should be a thick soft mass with little or no sign of whey separation. The curds and whey are churned for a few minutes until the curd breaks up into a fine pulp. Pure cold water (about the milk quantity) is now added. Churning is now continued until butter is seen to collect on the surface. A second smaller quantity of water (about ¼ milk quantity) should be added and churning continued for a few minutes more. All the butter will now have come and will float on the butter-milk (*ták*). The beater should be removed from the churn and the butter skimmed off. The butter is usually gathered deftly by the hand and placed in another vessel. It drains free of butter-milk to some extent, but no attempt is made to wash it. Butter made as above comes fairly firm during the cold season if churned in the early morning.

I obtained the following results from 5lb of buffalo milk, churned as above :—

Curd kept 16 hours;
1st water added after churning for 4 minutes;
2nd ditto ditto 12 ditto;
butter all come in 16 minutes;
7½ oz. of butter obtained from 5lb of milk;
butter yielded 77.3 per cent. *ghí*, *i.e.*, clarified butter."

BERAR.

IX. — BERAR. — The Officiating Director of Agriculture (Captain R. V. Garrett) furnished a reply to **Herr Martiny's** questions of which the following abstract may be here given :—

(1) The old Indian churn is still in use in Berar, (2) the inhabitants of which are of the Aryan type. (3) The earthen or metal pot holding the milk is called in Marathi *Mathan*. The whish is called *Ravi*. There is no collective name for the whole apparatus. (4) This is the churn of the Aryan population. There are no Malayan races in Berar, and no information as to the churns in use by them is therefore available. (5) Almost every cow and buffalo owner has his own churn. The churns in use hold about a gallon, the largest would not contain over 5 gallons. Churns holding 30—35 gallons, as also the custom of bringing milk from a distance

to a common or public churn, are not known in Berar. (6) No other churn is in use. BERAR.

The Deputy Commissioner, Akola, Hyderabad, gives the following information as to the manufacture of the whisk or *Ravi*:—The shaft is ordinarily made of *Dhaman* wood, which is tough and elastic. For the heads, the best woods are considered to be *Dahi Palas* (**Cordia obliqua**) and *Butikas* (**Elæodendron glaucum**). The former is said to thicken the curds, and the latter to prevent the churning being spoilt by the glance of a stranger falling upon the operation.

X.—MYSORE AND COORG.—Mr. L. Ricketts, Inspector-General of Forests, Mysore, has furnished the following memorandum on the subject of the churns in use in that State. Perhaps the most interesting part of Mr. Ricketts' memorandum may be said to be his description of the Malnad churn, which may be described as a joint or *chunga* of bamboo with a piston fitting within, which agitates the milk vertically, on the principle of the churn most generally used in Europe, and not by the rotatory movement of the so-called Aryan churn. In a country that abounds with bamboo, the joints of which lend themselves so readily to this contrivance, it is significant that churns similar to those of Malnad are not more frequently met with. The Coorg churn is also extremely curious and is probably an earlier pattern than that in the Malnad. The motion is vertical, not rotatory. MYSORE.

Description of churns.

1. No vessels of any particular material or shape are used for churns in the Mysore State. The vessels commonly employed are earthen pots measuring from two to twenty seers, or from two imperial quarts or half a gallon to five gallons. In some parts of the Malnad or hilly tracts where thick hollow bamboos are available, churns are made of such. In more civilized parts of Malnad, churns made of tin similar to the churns of bamboo *chungas* are used. The churn is called *Mosaru madikay* in Kanarese.

Description of churn-staff.

2. The churn-staff is of different kinds. It is called *Mottu Kola* or *Kadagolu* in the Kanarese language of this Province. The commonest one is a bamboo stick the thick end of which is fastened into a hole in the centre of a whirl which is generally made from the heart-wood of white babul (**Acacia leucophlœa**). The whirl made of this wood is said to produce more butter than that of any other wood. The sizes of whirls vary, and are in proportion to the quantity of curds in which they are to be worked. To work in pots containing five gallons of curds, churn-staffs to which two or three whirls are attached are employed.

How large churn-staffs are worked.

3. Large churn-staffs are worked in the following manner:—The churn-staff is attached to a pillar or post by two strings, the whirl at the bottom of the staff being put into curds in a pot placed against the pillar or post by two strings and turned rapidly round and round by a string worked with both the hands, as shown in the accompanying drawings. The large churn is used only by those who own a large number of cows, or by those who make large quantities of butter for manufacturing *ghí* which is an article of commerce throughout India, it being extensively used by the Natives with meals or for frying different kinds of eatables, currys, etc.

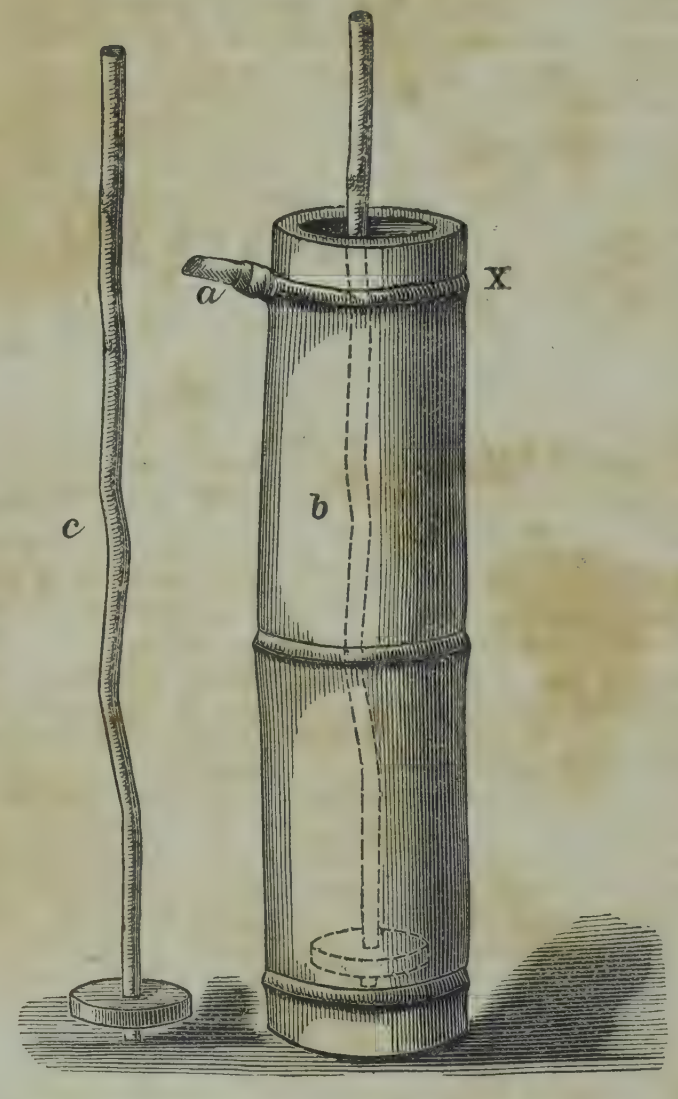
MYSORE.

How hand-churn-staffs are worked.

4. The hand-churn staff is used in the house of almost every Native to make butter or butter-milk from curds under one gallon, and it is worked only with the bare hands in small pots containing curds.

Malnad churn and churn-staff.

5. In parts of *Malnad*, the churn-staff used is not a whirl, but a kind of piston which is worked up and down in the curds in a hollow bamboo reed or a tin vessel made like it. The following drawing shows the bamboo and piston churn, an interesting feature of which consists of the small branch left near the mouth as a handle :—



Mysore Churn—
(*a*) Branch left as handle.
(*b*) Bamboo, portions of four joints : joint X being left to give strength.
(*c*) Piston.

MYSORE.

Process of making butter.

6. Butter is not made from pure milk. But milk is well boiled; and when it is lukewarm, a small quantity of butter-milk is put into it to form it into curds from which butter is separated by the operation of the churn-staffs above described.

Churn in use in this State is believed to be that of Aryan population.

7. It is believed that the churn and the churn-staff in use in the Mysore State are those of the Aryan population. It is not known here what kind of churn is used by the Malayan population. The Sanscrit name of the churn is *Manthaha*, of the churn-staff, *Mantha-dandaha*, and of the churn-string, *Manthanaha*.

The churn and churn-staff are referred to in many Sanscrit works. The following Sanscrit stanza is worthy of being quoted :—

योषागणेनवरदध्निविमध्यमाने घोषालयेषुदधिमंथनतौ घोषः।

रोषात्कलिंविदधतेककुभश्चकुंभाः श्रेषाद्रिशीखरविभोतवसुप्रभातं ॥

(Oh Lord, Good morning to Thee! The great noise produced by thousands of herdswomen churning curds early in the morning in their churns is so formidable as to break the churns themselves and cleave the air in all directions.)

Coorg.—The Commissioner of Coorg reports :—(1) The churn in use in Coorg is a piece of hollow bamboo, the milk being worked in it with a stick, at the end of which is attached a cocoanut-shell. (2) This churn is used by Aryan races. (3) The vernacular term for churn is *Andé*. (4) The churn used by Malayan families is unknown. (5) The custom of bringing milk from a distance to be churned does not prevail in Coorg. Each cow-holder has his own churn. No other form of churn is known in this district.

MADRAS.

XI.—MADRAS.—The following report on the subject of the churns that are in use in South India has been furnished by **Mr. R. C. K. Sabba Row**, Sub-Assistant Director of Agriculture :—

1. The old Indian churn is used throughout India. The churn referred to in the 10th Skandha of Maha Bhagavatam as employed by Krishna's mother is the same as that used by the cowherds now.

3. A churn is called in Tamil *Mattu*, in Telegu *Kauvam*, and in Canarese *Kadigolu*. The Indian churn is of two kinds. One kind consists of an earthenware pot, into which is placed a piece of solid bamboo about 4 or 5 feet long, split at one end into 4 strips each about a foot long. The strips are bent outwards and held apart from each other by small cross pieces of bamboo inserted between the ends. The lower part of the bamboo thus forms a beater 4 inches square. The 'beater' is bound all round with strips of palmyra stalk which are smooth and glossy outside. This kind of churn is called in Tamil *Nilai Mattu*, in Telugu *Pedda Kauvam*, and in Canarese *Dodda Kadigolu*. In the other kind of churn, the beater consists of a shaft of bamboo or wood 1 to 2 feet long stuck in a disc of wood, generally, of **Bassia longifolia**, with serrated edge. This sort of churn is called in Tamil *Kai Mattu*, in Telegu *Chinna Kauvam*, and in Canarese *Sanna Kadigolu*.

5 & 6. If the quantity of milk to be churned exceeds 5 measures, the *Nilai Mattu* is used. As the cost of the churn is hardly six pence, every cow-herd possesses one. Nobody takes his milk to a distant place to be

THE INDIAN CHURN. A Précis of Official Correspondence.

MADRAS.

churned. As much as 30 Madras measures or 11 gallons of milk may be churned at a time. The manner of working the churn is as follows :—

Two loops of rope are fastened to a pillar of the house, one a foot above the other. Sometimes, two bows (sketch on the margin) made of palmyra stalk (with the hollow side turned outward) and a piece of rope string between its ends are fixed to a pillar of the house, instead of the loops of rope. The shaft is passed through the loops or the bows. The 'beater' of the churn is immersed in the milk. On the shaft of the churn, between the two loops of rope or the bows, a rope is wound, and one end of the rope is taken in each hand. By pulling one end of the rope and then the other alternately the 'beater' is spun. Care is taken that the 'beater' does not come in violent contact with the bottom or the sides of the pot containing the milk. As palmyra stalk is very smooth, there is less friction when its bows are used instead of the loops of rope. After the milk has been churned for about half an hour, a little hot water is added and the churning is resumed for about half an hour more. The particles of butter will then have risen to the surface. For the purpose of collecting the butter the milk is then beaten with the hand. If a cow-herd wishes to sell his milk as curds, he skims off the cream and churns it separately. If he wishes to sell his milk as buttermilk, the whole of the milk is churned. As a rule, butter is made from buffaloes' milk, to be converted into *ghí* and only to a small extent from cows' milk. A cow-buffalo yields, on the average, 6 ounces of butter per Madras measure of milk (100 cubic inches). A cow yields only about 3 to 3½ ounces per measure.

If the quantity of milk to be churned be more than 1 Madras measure and less than 5 measures, a *Kai Mattu* of a large size (with a shaft 3 feet long) is used in the same way as the *Nilai Mattu* above described. If the quantity be a measure or less, a small *Kai Mattu* with a shaft only about a foot or 1½ feet long is used. The disc being immersed in the milk, the shaft is twirled between the palms of the hand without any rope or other appliances. Very often the object in using the *Kai Mattu* is not to obtain any butter whatever, but simply to reduce the curds to a homogeneous thick mass of buttermilk.

BURMA.

XII.—BURMA.—The Officiating Director of the Department of Land Records and Agriculture reports that enquiries made in several districts up to date have failed to disclose the use of churns other than that described by Herr Martiny. The few churns which are in use among the Burmans are copies of churns used in Bengal. It should be added that their religion teaches the Burmans that all available milk should go to the calves, hence cows are rarely milked and "*ghí*" or melted butter is not used for cooking purposes.

CALCUTTA ;
July 30th, 1895.

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